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CRUDE OIL SUPPLY AND DEMAND: MAJOR ISSUES AND ALTERNATE SCENARIOS

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EXECUTIVE SUMMARY

A research project has been undertaken by the Canadian Energy Research Institute to analyse the impacts of changing crude oil supplies in Canada. This paper reports progress related to the first phase of that project.

The theme throughout is that the refining sector is the key interface between changes in crude oil supply and refined petroleum product demand. The emphasis has been to document these changes and develop forecasts of crude oil supply and demand for use in the final research phase.

The major points discussed in this paper are summarized below.

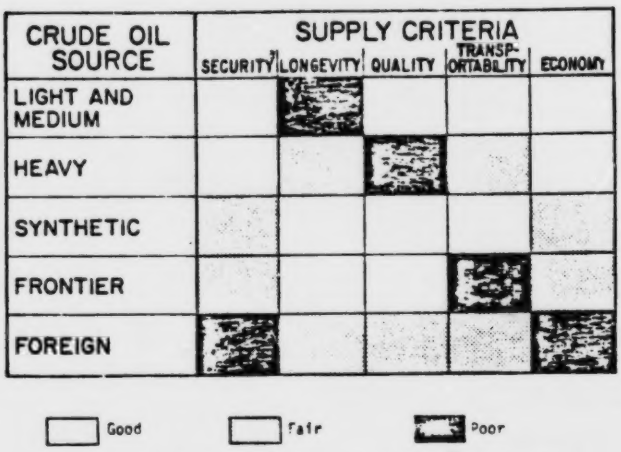
1. Five major types of crude oil supply are addressed. They are:

   - light and medium
   - heavy
   - synthetic
   - frontier
   - foreign

   The relative attractiveness of these oil supply sources can be evaluated in terms of five criteria. They are:

   - security from supply interruption;
   - longevity of supply capability;
   - quality as a refinery feedstock;
   - transportability from production source to refinery; and
   - economy relative to other feedstocks.

   The following matrix illustrates how the five supply sources rate against the five criteria for evaluation of their attractiveness. Synthetic and frontier oil will be the most attractive oil supply sources for the future as technical hurdles are overcome.



Relative Attractiveness of Crude Oil Supplies

2. A three-case forecast of crude oil supply has been developed. Highlights of each case are summarized below.

	1985		2000	
	$10^3m^3/d$	%	$10^3m^3/d$	%
Low Case				
· light and medium	133.9	70	58.6	35
· heavy	29.6	16	29.3	17
· synthetic	26.1	14	80.0	48
· frontier	0	0	0	0
Total	189.6	100	167.9	100
Base Case				
· light and medium	140.4	66	74.9	26
· heavy	41.6	20	40.5	14
· synthetic	29.0	14	120.0	42
· frontier	0	0	50.0	18
Total	211.0	100	285.4	100
High Case				
· light and medium	155.0	67	87.6	23
· heavy	45.5	19	53.7	14
· synthetic	31.9	14	160.0	42
· frontier	0	0	80.0	21
Total	232.4	100	381.3	100

The relative importance of conventional light and medium crude will decline significantly from nearly 70 percent of domestic supply in 1985 to only 25 percent in the year 2000. Synthetic and frontier oil will increase from a relatively minor 14 percent of domestic supply in 1985 to between 50 and 60 percent in the year 2000. Clearly, a major geographic and technical shift in domestic supply patterns is imminent.

3. Current crude oil price penalties for density and sulphur should be increased by more than a factor of two. These price penalties are too low and as such refiners are not adequately compensated for processing crudes with a high density and/or sulphur level. The resulting low demand by refiners for poor quality crudes could lead to shut-in heavy oil productive capacity.

4. A three-case forecast of refined petroleum product demand has been developed as well. Highlights of the various crude oil demand cases are summarized below.

	1985 $10^3m^3/d$	2000 $10^3m^3/d$
Low Case		
East[a]	200.1	156.0
West[b]	84.9	84.0
Total	285.0	240.0
Base Case		
East	212.3	201.5
West	90.2	108.5
Total	302.5	310.0
High Case		
East	224.6	247.0
West	95.4	133.0
Total	320.0	380.0

[a]Ontario and east
[b]Manitoba and west

Central and eastern Canada's share of total demand will fall. Product demand will moderate due to reductions in motor gasoline requirements and a shrinking market for fuel oils due to natural gas penetration in those areas. Western Canadian demand will be much stronger than in the east, with very large growth in diesel and jet fuel requirements. Gasoline demand will fall in all cases.

5. Based on a range of aggregate crude oil supply and demand forecasts, as well as relatively optimistic probabilities of each occurring, a computer model indicates the following conclusions regarding Canada's future oil supply/demand balance.

   - The expected value of oil imports will peak at 83,700 m^3/d (28 % of domestic demand) in 1985 and improve steadily to the year 2000 where (based on the computer analysis) a modest exportable surplus of 5,800 m^3/d is expected.

   - The probability of self-sufficiency will increase from zero in 1985 to 0.54 in the year 2000. The probability of large-scale foreign dependence will fall from 0.22 in 1985 to 0.06 in the year 2000.

   - The federal government's goal of self-sufficiency by 1990 will not likely be achieved unless there is a very substantial departure from anticipated crude oil supply and demand patterns. In fact, the expected value of oil imports for 1990 is 71,000 m^3/d (24% of domestic demand). While the probability of imports being less than one-third of domestic demand in that year is .82, the probability of imports being eliminated by 1990 is close to zero.

6. A transportation algorithm (a linear programming technique) was used to allocate specific crude types to specific refining regions. The allocation was based on:

   - pipeline infrastructure and operation;
   - oil supply patterns;
   - political factors; and
   - foreign oil avails.

Preliminary analysis of base case conditions indicates that foreign oil will play a major role in determining the refining

impact of changing oil supplies for 1985 and 1990. By 1990, domestic supply capability for Quebec will fall to 43 percent of Quebec demand, and the Toronto-Montreal oil pipeline will run at only 65 percent of capacity.

Synthetic oil will account for one-third to one-half of feedstock usage in almost every refining region by the year 2000. All major capacity additions in Alberta will be designed to run synthetics. Atlantic demand will be fully met by frontier oil, as will 14 percent of Quebec demand. The light sweet conventional crudes will be consumed in Alberta.

7. Future research will use a computer model of the Canadian refining industry to analyse how changes in feedstock availability will affect refiners. Three areas of specific interest will be to measure the impact of:

   - various supply/demand scenarios;
   - domestic or foreign supply disruption; and
   - government crude oil allocation.

Chapter 1

INTRODUCTION

The purpose of this working paper is to outline preliminary findings of a study dealing with the impact of changing crude oil supplies in Canada. The emphasis is on:

- documentation of crude oil supply and refined petroleum product (RPP) demand patterns;
- development of detailed crude oil supply and demand forecasts for future research; and
- analysis of Canada's overall oil and RPP supply/demand balance.

An underlying theme throughout the project has been that refiners must make certain technical and economic decisions regarding plant configuration and operation to meet oil product demands. These decisions are influenced primarily by the dynamics of the crude oil and RPP markets. Therefore, the single most important variable in long-term planning for the industry is the market environment in which it operates.

Every strategic decision made by refiners in the future will be based on their perception of market characteristics. In this paper the author identifies crude oil and RPP market trends and outlines their general implications for Canada and the industry.

1.1 The Issues

Currently, this country imports approximately one-quarter of its total crude oil requirements.[1] Relative to domestic oil, these foreign supplies are lower in quality, less reliable, and significantly more expensive. Therefore, certain net benefits may be realized if reliance on foreign sources of oil is minimized.

The motivation to strive for oil self-sufficiency may be characterized by three major benefits to Canada. They are:[2]

- Security of Supply[3]
- Employment and Investment[4]
- Balance of Payments.[5]

In addition to these benefits of self-sufficiency, it also makes good economic sense to exploit domestic sources of oil that could be developed for a supply price lower than what Canada is, or will be, paying for imported crude.

The analysis of Canada's aggregate oil balance simply deals with the difference between total oil supply and total oil demand. The emphasis of this aggregate approach is to focus on the benefits of self-sufficiency outlined above. Another issue, however, is how changes in specific crude supplies and refined product demands affect the overall supply/demand picture.

The pattern of crude oil supply for Canadian refiners will change substantially in the future: the availability of light and medium crude from both domestic and foreign sources will fall sharply; domestic supplies will include more synthetic oil from tar sands and heavy crude upgrading plants; and heavy foreign crudes will dominate imports.

These changes will have an impact on the industry's ability to meet refined petroleum product demands. Heavier imported crudes will result in a larger yield of heavy fuel oil at a time when demand for that product is expected to fall. Increases in synthetic crude may result in product quality problems for some transportation fuels, just when the relative demand for these fuels is expected to increase.

The refining industry may thus be characterized as the interface between crude oil supply and refined petroleum product demand. A certain degree of flexibility exists in this interface, allowing the refiner to adjust plant operation to compensate for differences between product yield from a certain crude type and refined petroleum product demands. This flexibility is limited, however. If the gap between RPP

yield and RPP demand is wide, refiners will face serious problems meeting consumer demands (assuming a fixed level of refinery flexibility). The refiner's role as interface between supply and demand will become increasingly critical, particularly as preferred feedstocks become scarce.

Refinery modifications necessary to increase production flexibility or capacity are very expensive. Capital costs are high and escalating rapidly, and operating costs are significant. Therefore, the decision to make such modifications will only be made if the supply/demand outlook indicates that they are essential. Some of the issues that will influence a refiner's decision to make these costly expenditures are listed in some detail below.

Domestic Supply Factors

- Conventional light and medium crude oil production is decreasing rapidly.
- Heavy crude oil production technology is improving and will increase the potential supply of heavy oil.
- Upgraded heavy crude oil production will increase the availability of higher quality synthetic oil and reduce a glut of heavy crude.
- Synthetic crude oil production from the tar sands could be increased significantly.
- Frontier crude oil production potential exists. Timing, volumes, and quality of supply are unclear, however.
- Regional supply of specific crude types will be a function of pipeline infrastructure, historical supply patterns, political choice and foreign oil availability.

Foreign Supply Factors

- Availability of all crude oil types in world markets is decreasing.
- Security of crude oil supplies from traditional exporters is in question.
- Heavy crude oil will increasingly dominate imports.
- Foreign crude oil prices will remain very high.

Domestic Demand Factors

- Total eastern Canadian refined petroleum product demand will moderate. This down turn will be partly due to substantial reductions in fuel oil demand resulting from natural gas substitution.
- Total western Canadian refined petroleum product demand will increase, primarily in the transportation fuel markets.
- Commercial transportation fuel demands will continue to increase rapidly.
- Gasoline demand will fall.
- Regional demand trends will differ due to circumstances unique to each region.

Refining Industry Considerations

- A capacity shortfall exists in western Canada, and demand growth indicates capacity additions will be required.
- Substantial excess distillation capacity exists in eastern Canada.
- Fuel oil upgrading capacity is limited in eastern Canada and demand trends indicate additional upgrading facilities may be required.

1.2 Study Objectives

This paper is the first of a two-phase project. Stated simply, the overall objectives of the total project are:

- to determine the ability of Canadian refiners to adjust to changing sources of crude oil and changes in refined petroleum product demand; and
- to evaluate the impact of these changes on the petroleum industry.

The objectives of this first phase are more specific in nature. They represent the detailed findings reported in this paper. They are:

- to formulate three representative cases of crude oil supply and three representative cases of refined petroleum product demand;
- to develop a detailed supply/demand data base for use in the subsequent research phase; and

- to evaluate the aggregate effect on Canada's oil balance of varying supply/demand scenarios taking the uncertainties inherent in such forecasting into account.

1.3 Study Methodology

This paper consists of four major chapters. Chapters 2 and 3 provide background information related to crude oil supply and refined petroleum product demand. The chapters conclude with the development of three cases of crude oil supply (Chapter 2) and three cases of refined product demand (Chapter 3).

Chapter 4 brings the supply and demand forecasts together. At the aggregate level, a probabilistic technique is used to formulate a framework for evaluation of expected effects of certain supply/demand scenarios on Canada's foreign supply dependence. At the source-use specific level, detailed supply/demand matrices are developed showing particular crude oil sources and their ultimate consumption by refining region. This data, along with specific refined petroleum product demands, will be the foundation for the second phase of the project.

Chapter 5 contains a discussion of future research. Details of the industry refining model and proposed impact analysis are presented.

Footnotes

[1]See Tables 2.2 and 2.3. On a net basis, Canada imported 23.2 percent of total domestic requirements during the first quarter of 1980.

[2]J. A. Dawson and Z. C. Slagorsky, Benefits and Costs of Oil Self-Sufficiency in Canada (Calgary: Canadian Energy Research Institute, February 1981), Study No. 12.

[3]The economic impact of a significant reduction in crude oil supplies would be severe. The potential volatility of foreign oil markets is such that dependence on these supplies represents a level of risk that may be unacceptable. Minimizing dependence on foreign oil would help insulate Canada from the downside consequences of short-term disruption in world oil supplies and long-term creeping supply contraction.

[4]Replacing imported crude with increased domestic production would result in increased local investment and direct employment benefits. In addition, multiplier effects would generate gains throughout the economy. The benefits are particularly attractive for possible development of the Atlantic Shelf South and Labrador East Newfoundland Shelf geological areas, given high regional unemployment in eastern Canada.

[5]The initial impact of a reduction in oil imports would improve Canada's balance of payments. Second and subsequent round effects, however, may not be so beneficial to our economy. For example, an associated strengthening of the Canadian dollar could reduce the competitiveness of Canadian exports in other sectors.

Chapter 2

CRUDE OIL SUPPLY

During the first half of 1980, a total of 306 thousand cubic metres per day of crude oil was run by 38 different refineries in Canada.[1] This represents a total feedstock value of well over $30 million per day[2] and clearly demonstrates that, in terms of volume and value, crude oil supply makes up a very important part of the Canadian petroleum scene.

As indigenous sources of crude oil change and the supply of foreign oil decreases in quality and availability, the efficient management and utilization of crude oil supplies will become more critical. In order to analyse the impact of these changing patterns, it is essential that a clear picture of crude oil supply complexities be developed.

2.1 Supply Criteria

The degree to which Canada is dependent on foreign oil supplies is critical in both strategic and economic terms. As such, the concept of oil self-sufficiency (or at least self-reliance), has become the proclaimed goal of energy strategists and policy makers.[3] Relative to other industrialized nations, Canada is better off than most in this regard. The potential exists in Canada for a moderating trend in oil consumption as well as increases in domestic supply capability.[4]

The current supply deficiency in Canada dictates, however, that consideration be given to the role that both domestic and foreign crude oil supplies play in Canada's oil balance. For example, the quality and availability of crude oil in Canada varies by region, with the Atlantic provinces and Quebec almost totally dependent on oil from foreign sources. Certain supply patterns have evolved over the years,

with western Canada's productive capacity being inadequate to meet domestic demand. At least in the short-term, foreign crude will continue to be a major source of supply, however risky and expensive it may be.

The critical task with regard to crude oil supply (both foreign and domestic) is to develop and maintain sources of crude oil that satisfy five major criteria. These supply criteria are:

- Security
  Dependable, steady sources of raw materials are critical to any manufacturing industry. Given the inherent risk associated with foreign oil supplies, Canadian refineries could only absorb supply interruptions to the limit of on-hand refinery crude oil stocks and excess pipeline inventories. Extended supply shortfalls and inability to replenish depleted inventories represent serious downside consequences for refiners who require high throughput to meet consumer demands and profitability requirements.

- Longevity
  Production of light and medium crude oil from conventional Canadian sources is declining at a very rapid rate. To ensure the continued ability to meet future refined petroleum product demands, additional long-term sources of supply must be developed. This may include development of new domestic supply sources such as frontier regions and the oil sands, as well as long-term supply relationships with exporting nations. The strategic objective is to avoid long-term creeping supply shortfalls.

- Quality
  Technical and economic constraints hamper the ability of refiners to manufacture heavy crude oils into a product mix that matches consumer demands. The result is a surplus of heavy fuel oil and tight supplies of lighter

products. Until the technical flexibility of the refining industry is improved, it is essential that feedstock quality be maximized to economically meet required product yields. Since both domestic and foreign supplies of good quality crude are declining, this goal will gain increasing importance, particularly if the relative demand for light refined products remains high.

- Transportability

Supply planning requires an analysis of the method and ease of transporting certain crude types. For example, very heavy foreign crude may cause operating problems for Portland Pipe Line in the winter. Similarly, heavy Lloydminster crude must be blended with condensate or light crude to be transported through InterProvincial Pipe Line. In addition, certain crude types are physically unavailable to certain refiners. From a long-range planning perspective, potential Beaufort and Hibernia production requires the resolution of several transportation questions. These oil reserves are without value unless the raw resource can be transported to refiners. Therefore, the overall transportability of certain crude types will be taken into account when evaluating preferred feedstocks.

- Economy

The relative economic value of various crude oil supplies is a function of the

- crude oil acquisition cost,
- refined product yield,
- refined product prices, and
- operating costs.

Based on these four parameters, certain crude types are more attractive than other crudes as feedstock.

The satisfaction of all five of these objectives is a difficult task. From a strategic perspective, circumstances will dictate the priority to be placed on each, and these priorities will vary from country to country, region to region, and refinery to refinery.

Figure 2.1 roughly illustrates the relative attractiveness of different types of crude oil supply, as measured by the five supply criteria outlined above. For example, while Canada's production of light and medium conventional crude is indeed secure from supply interruption (security), it is declining at a rate of nearly 10 percent per year, and is therefore certainly not long-term in nature (longevity). In addition, crude oil from frontier areas such as the Beaufort Sea is not easily transportable due to technical uncertainty (transportability), and heavy western Canadian crude is difficult to refine given current product demands and refinery capabilities (quality). Finally, crude oil pricing in both foreign and domestic markets is a complex issue and it is the challenge of the supply function to secure feedstocks that will generate the greatest economic return (economy).

These five criteria, both implicitly and explicitly, form the basic framework upon which supply-side strategies and policies are modeled at the corporate level. As oil supply circumstances change, tradeoffs will occur between each of the five objectives. Through analysis of the current and future crude oil supply situation, the relative importance of each supply criterion can be assessed and the subsequent implications for refiners and consumers can be evaluated.

The current crude oil supply situation in Canada is briefly described in the following sections.

2.2 Regional Supply/Demand Imbalances

The four western provinces account for nearly all of the crude oil production in Canada. On the demand side, however, western Canadian refineries run only one quarter of total crude oil processed in Canada.[5] Table 2.1 illustrates the regional crude oil supply and demand imbalance. In absolute terms, Ontario is the most oil-poor

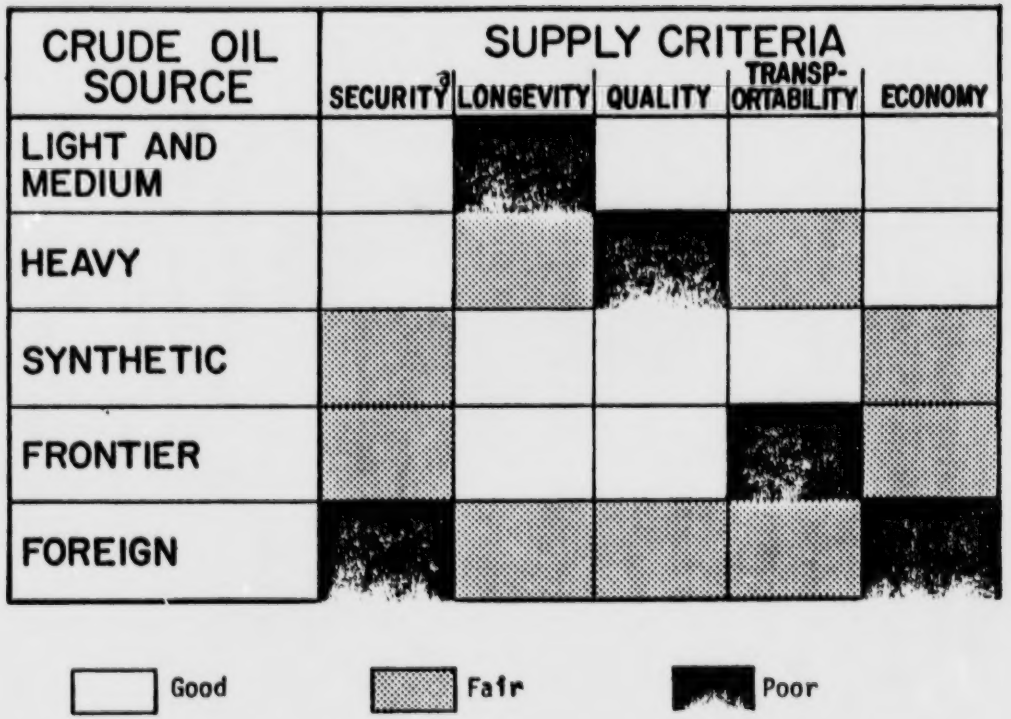


FIGURE 2.1: Relative Attractiveness of Crude Oil Supplies

[a]Includes risk of near-term supply disruption

TABLE 2.1

REGIONAL CRUDE OIL SUPPLY AND REQUIREMENTS
first quarter, 1980

Region	$10^3m^3/d$			Production/ Requirement Ratio
	Production[a]	Requirements[b]	Surplus <Deficit>	
Atlantic	-	41.2	<41.2>	0
Quebec	-	84.6	<84.6>	0
Ontario	0.3	92.7	<92.4>	0
Manitoba	1.6	8.6	<7.0>	0.2
Saskatchewan	26.6	8.7	17.9	3.1
Alberta	219.4	24.5	194.9	9.0
British Columbia	6.1	28.6	<22.5>	0.2
Total	254.0	288.9	<34.9>	0.9[b]

[a]This figure includes heavy crude oil production currently exported to the United States.

[b]These are net requirements after imports/exports and inter-provincial transfers in/out. The figures include LPG's and other materials used.

region in Canada. The combined oil deficiency (for domestic consumption) of Ontario, Quebec and the Atlantic provinces was 218.2 $10^3 m^3/d$, compared to a net surplus of 183.3 $10^3 m^3/d$ for the western provinces. Clearly this surplus western Canadian production is not sufficient to meet all eastern Canadian crude oil demands.

Based on a federal policy formulated in 1960 designed to create markets for Alberta crude, it was determined that all refining centres west of the Ottawa Valley should be supplied by western Canadian oil rather than crude from foreign sources.[6] Since this decision, an extension of the InterProvincial Pipe Line has given Montreal area refiners access to domestic crude to the extent that productive capacity and pipeline capability dictate. For Ontario and western Canada, crude oil supply is met by western production.

Figure 2.2 illustrates the effect that regional supply/demand imbalances have on crude oil utilization. In 1979 western Canadian crude accounted for the vast majority of feedstock in all regions west of the Ottawa Valley as well as a large portion of feedstock utilized in Montreal. The remaining Quebec deficit (about 38 percent) plus all crude oil for the Atlantic provinces was obtained from foreign sources.

Eastern Canada accounts for about 73 percent of the total crude oil refined in Canada. As indigenous western Canadian productive capacity declines, more and more of this eastern demand will be met by foreign crude. Montreal refiners will absorb most of the increasing supply shortfall, primarily because they have direct access to imported crude via Portland Pipe Line and by tanker along the St. Lawrence. The impact of a physical decrease in western crude oil production would be further compounded by near-term demand increases west of the Ottawa Valley, thereby further reducing the volume of domestic crude oil available for the Quebec market and increasing the possibility of using foreign crude in Ontario via reversal of the existing pipeline to Montreal.

The projected crude oil supply/demand imbalance by region in Canada will have a major impact on Canadian refiners. Given that the availability of domestic crude oil is declining, and the fact that

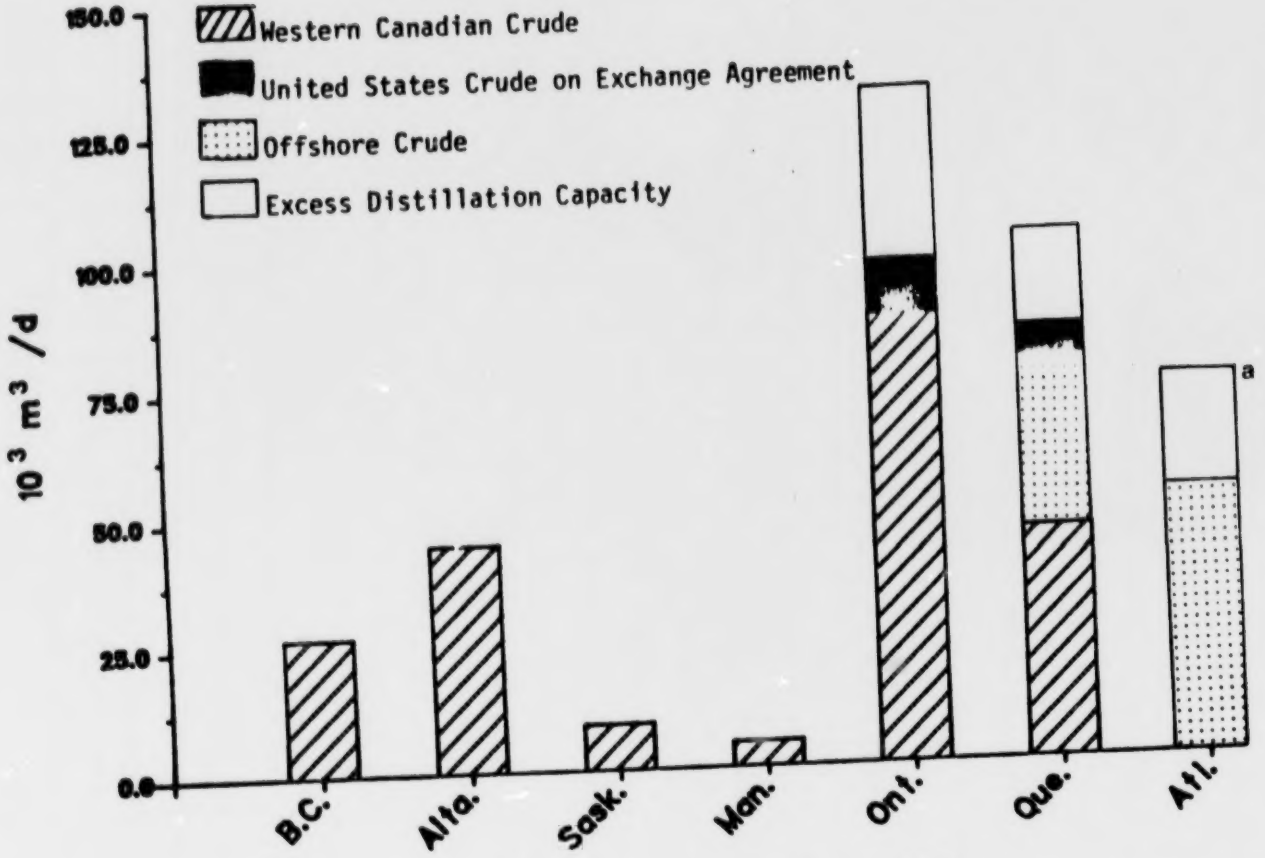


Figure 2.2: Crude Oil Usage by Region, 1979.
SOURCE: Statistics Canada. Catalogue Nos. 26-006 and 45-004.

[a] excludes capacity of mothballed Come-by-Chance refinery.

dependence on foreign supplies is wrought with uncertainties, there is a certain degree of risk for Canadian refiners heavily reliant upon foreign oil. Therefore, trends in domestic and foreign crude supply sources will have a major impact on Canadian refiners.

2.3 Sources of Supply

Currently, Canada's crude oil needs are met mostly by domestic supplies. Table 2.2 portrays the actual sources of crude oil received by Canadian refiners. In total, 254.4 $10^3m^3/d$ of crude oil was produced from Canadian sources. Approximately 15.5 $10^3m^3/d$ was heavy crude oil for which there were no Canadian markets and this portion was exported to the United States. A further 24.3 $10^3m^3/d$ went to the United States under exchange agreements. An equivalent volume would be imported into eastern Canada from both United States and offshore sources. The remaining crude oil production of 214.7 $10^3m^3/d$ flowed directly to Canadian refineries. Imports (including exchange volumes), totalled 96.4 $10^3m^3/d$, indicating a total supply to Canadian refineries of 311.1 $10^3m^3/d$.

In percentage terms Table 2.2 is not really a true indicator of Canada's dependence on foreign crude oil, since exchanges artificially boost import figures. Table 2.3 points out that Canada relied on foreign sources for only 23.2 percent of requirements during the first quarter of 1980 compared with the 31.0 percent as indicated by Table 2.2. In addition, if heavy oil currently being exported could be processed in Canada, dependence on foreign crude would fall to about 18.2 percent.

It is critical to note, however, that domestic crude oil production is falling, necessitating further imports. Also, the patterns of foreign avails are changing with shifts toward less secure, higher priced, harder to refine crude types. As well, domestic supplies are changing in terms of both source and availability.

TABLE 2.2

CANADIAN CRUDE OIL SUPPLY BALANCE
first quarter, 1980

	$10^3m^3/d$		Percent of Total Supply	
Domestic Production:				
Alberta	219.3		70.5	
Saskatchewan	26.6		8.5	
British Columbia	6.1		2.0	
Manitoba	1.6		0.5	
Northwest Territories	0.6		0.2	
Ontario	0.3		0.1	
Total		254.5		81.8
LESS: Exports to U.S.		<39.8>[a]		<12.8>
Net Domestic Supply		214.7		69.0
PLUS: Imports from:[b]				
Iran	0.8		0.3	
Iraq	1.1		0.4	
Kuwait	2.8		0.9	
Saudi Arabia	35.3		11.3	
United Arab Emirates	2.3		0.7	
United States	19.3		6.2	
Venezuela	29.2		9.4	
Other	5.6		1.8	
Total		96.4		31.0
Total Supply		311.1		100.0

SOURCE: Canada, Statistics Canada, Crude Petroleum and Natural Gas Production (Ottawa: Supply and Services), Catalogue No. 26-006, January 1980, February 1980, March 1980.

Canada, Statistics Canada, Refined Petroleum Products (Ottawa: Supply and Services), Catalogue No. 45-004, March 1980.

Canada, National Energy Board, Operating Data July, 1980.

[a]This figure includes approximately 15.5 $10^3m^3/d$ of licensed heavy oil exports, 19.3 $10^3m^3/d$ of mid-continent exchanges, and 5.0 $10^3m^3/d$ of offshore exchanges.

[b]Includes about 5.0 $10^3m^3/d$ of offshore exchanges with the United States.

TABLE 2.3

CANADIAN DEPENDENCE ON FOREIGN OIL
first quarter, 1980

Supply Situations:	Domestic (%)	Foreign (%)	Total (%)
Existing exchanges and exports[a]	69.0	31.0	100
If exports only[b]	76.8	23.2	100
If no exchanges, no exports[c]	81.8	18.2	100

[a]This is the composition of actual crude oil utilized given existing exchanges and exports.

[b]This assumes exchange volume imports are considered as domestic supply.

[c]This assumes exchange volume imports are considered domestic supply, and exported heavy crude could, in fact, be processed in Canada.

2.3.1 Domestic supply

The precise sources of domestic crude oil examined in this paper are basically the major gathering streams in the four producing provinces. A total of 34 pipeline streams carry virtually all of the domestic crude oil production in Canada. These streams and their representative throughput volumes are shown in Table 2.4. About 80 percent of domestic supply is light and medium production, with heavy and synthetic crude accounting for the remaining 11 percent and 9 percent respectively. The five highest throughput pipeline streams (Federated, Rainbow, Texaco, Peace River and Pembina) account for over half of the total domestic crude oil and equivalent production.

Figure 2.3 illustrates these crude oil gathering systems and their relative proximity to the major Canadian supply and distribution point, Edmonton.[7] Other gathering system collection points (downstream of Edmonton) for injection into crude oil transmission pipelines are Taylor, B.C.; Edson, Alberta; Hardisty, Alberta; Kerrobert, Saskatchewan; Regina, Saskatchewan; and Cromer, Manitoba. Trans Mountain Pipe Line carries crude west to refiners in the Vancouver area. Inter-Provincial Pipe Line carries crude to refiners in Saskatchewan, Manitoba, Ontario and Quebec.

As shown previously in Figure 2.1, domestic sources of crude oil are relatively secure from supply interruption and the transportation network is well developed. Conventional light and medium production is on the decline, however, and the most likely replacement will be synthetic crude from the Alberta oil sands. In addition, production of heavy crude will be maintained and perhaps increased, with a significant portion of these supplies being upgraded to a product similar to synthetic crude from the oil sands.

The other potential sources of domestic crude oil are the frontier areas. Hibernia and the Beaufort Sea could have a major effect on traditional crude oil supply patterns in Canada. Technical considerations will likely preclude the transportation of Hibernia oil production by pipeline. The alternative is to load tankers directly

TABLE 2.4

DOMESTIC CRUDE OIL STREAMS
(approximate 1980)

Alberta			Saskatchewan			British Columbia			Manitoba & NWT				
Pipeline Stream	Type[a]	Throughput $10^{-3}m^3/d$	Pipeline Stream	Type[a]	Throughput $10^{-3}m^3/d$	Pipeline Stream	Type[a]	Throughput $10^{-3}m^3/d$	Pipeline Stream	Type[a]	Throughput $10^{-3}m^3/d$		
Federated	L	35.0	Westspur SES light	L	5.9	Trans Prairie B Lake	L	2.6	Trans Prairie (Man.)	L	1.4		
Rainbow	L	28.0	South Sask.	H	5.6	Trans Prairie Beatton River	L	1.3	Norman Wells (NWT)	L	0.5		
Texaco	L	26.0	Westspur SES medium	H	5.2	Blueberry	L	1.2					
Peace River	L	20.0	Husky & Manito	H	3.9								
Pembina	L	20.0	Bow River	H	1.8								
Gulf Alberta	L	15.0	Westspur batched light	L	0.4								
Syncrude	S	15.0											
Rangeland	L	11.0											
IOL: Redwater	L	10.0											
Bow River	H	7.0											
Suncor	S	7.0											
IOL: Ellerslie	L	5.0											
Cremona	L	5.0											
Husky	H	4.0											
IOL: Leduc	L	2.0											
Bow River	L	2.0											
Gibson	L	1.0											
Twining[a]	L	0.9											
Trans Prairie: B Lake	L	0.7											
BP	H	0.6											
IOL: Excelcior	L	0.5											
Valley	L	0.5										TOTAL	
TOTAL	L	182.6		L	6.3		L	5.1		L	1.9	L	195.9
	H	11.6		H	16.5		H	-		H	-	H	28.1
	S	22.0		S	-		S	-		S	-	S	22.0
	All	216.2		All	22.8		All	5.1		All	1.9	All	246.0

SOURCE: Canada, National Energy Board, Canadian Oil Supply and Requirements (Ottawa: Supply and Services, 1978); and actual throughput for certain streams.

[a] L = light (density less than 900 kg/m^3)
H = heavy (density greater than 900 kg/m^3)
S = synthetic

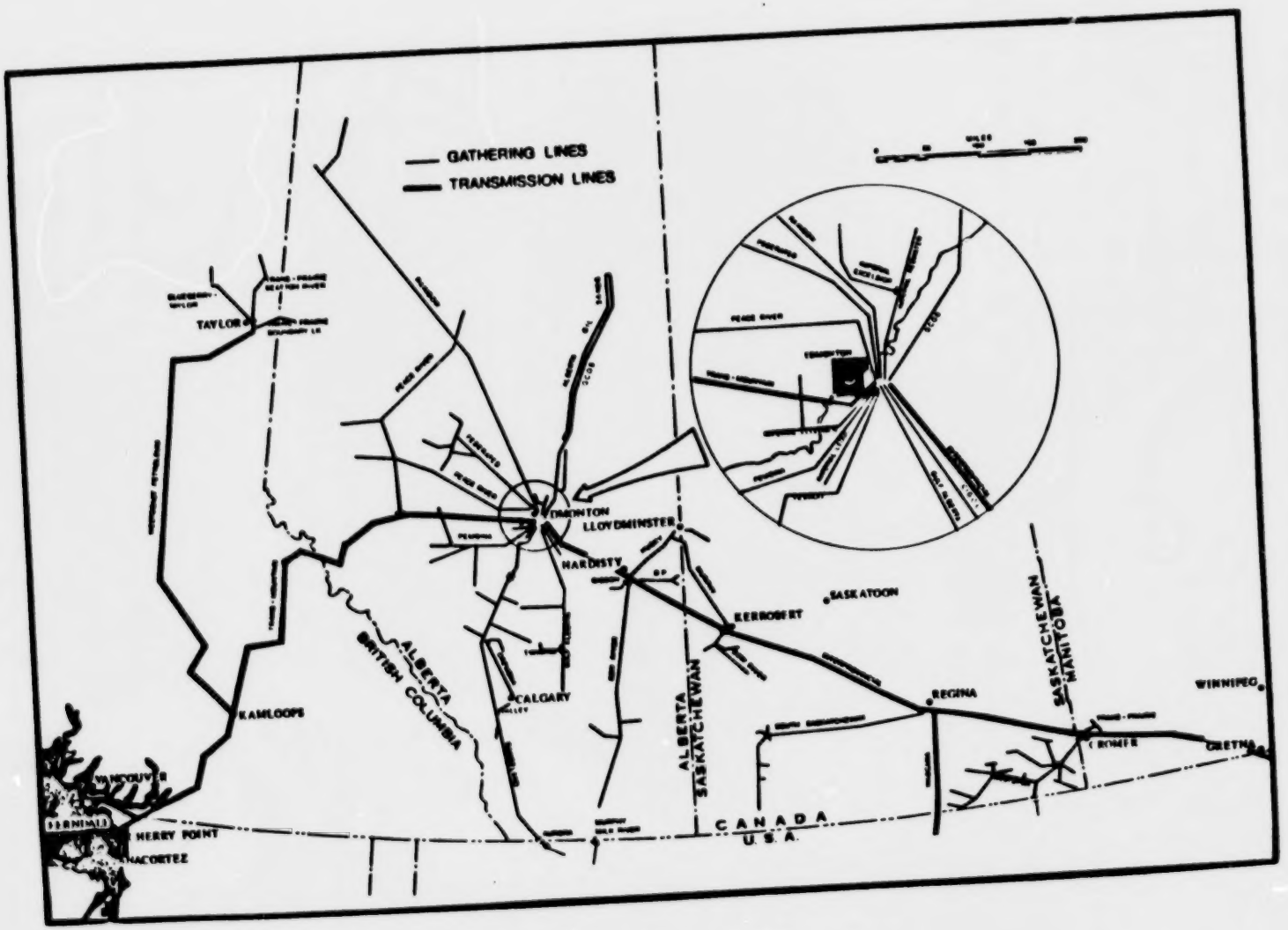


FIGURE 2.3: Major Crude Oil Gathering Lines.
SOURCE: National Energy Board. Canadian Oil: Supply and Requirements., 1978, p.20.

from floating oil storage facilities and then transport it to eastern refineries.

Two transportation options exist for Beaufort Sea production. Estimates indicate that a 36-inch pipeline from the Beaufort Sea would only be viable for oil throughput in excess of about 159,000 m^3/d. Any volumes below this would make icebreaking tankers more attractive.[8] Tankers would move the oil east through the Arctic to eastern Canadian refiners whereas a pipeline would move the oil south to interconnect with existing east/west oil transmission pipelines.

2.3.2 Foreign supply

Canada's net imports of crude oil during the first quarter of 1980 amounted to 72.1 $10^3m^3/d$. This crude was bought on the world market at world prices. In recent years Canada has imported crude oil from over twenty different nations, the supplies from each country varying with regard to the planning criteria of security, longevity, quality, transportability and economy. It must be realized that, in the face of limited production capability of exporting nations and shifts in world demand, the security and availability of these crude oil supplies will become increasingly uncertain.

Table 2.5 summarizes Canada's major sources of foreign crude by country of origin and type. The bulk of our foreign supply is from Saudi Arabia and Venezuela. The import of heavy Mexican crude is expected to increase marginally from the volumes illustrated. In general, imports from other countries are relatively minor, often meeting spot demands only.

2.4 Quality of Supply

The relative value to the refiner of a certain crude oil stream is a function of the product mix that crude will yield, and the actual unit cost to refine that oil vis-a-vis other crudes. As a rough cut, the use of a crude oil's density and sulphur content have evolved as quality measures of alternate feedstocks. These measures are by no means purported to be totally accurate assessments of the true charac-

TABLE 2.5

FOREIGN CRUDE OIL STREAMS
YEAR TO JULY 31, 1980

Middle East			Americas			Other			
Country/ Stream	Type[a]	Volume $10^3m^3/d$	Country/ Stream	Type[a]	Volume $10^3m^3/d$	Country/ Stream	Type[a]	Volume $10^3m^3/d$	
Abu Dhabi:			Mexico:			Angola:			
Murban	L	0.5	- Isthmus	L	1.5	Cabinda	L	0.3	
Umm Shaif	L	0.5	Maya	H	0.2				
						Nigeria:			
Iran:			Venezuela:			Medium	L	0.3	
Heavy	L	0.2	Bach/Centa	H	1.5				
			Bachequero	H	2.0	United Kingdom:			
Iraq:			Boscan	H	0.1	Flotta	L	0.4	
Basrah	L	1.1	Guanipan	L	2.7	Forties	L	0.5	
Kirkuk	L	2.6	La Rosa	H	1.4				
			Lagomar	L	1.8	Zaire	L	0.1	
Kuwait	L	3.0	Lagomedia	L	1.8				
			Lagotreco	L	1.8				
Saudi Arabia:			Laguna	H	2.2				
Heavy	L	0.8	Tia Juana 102	H	0.1				
Light	L	30.8	Tia Juana Light	L	6.1				
Medium	L	0.5	Tia Juana Med	L	0.8				
									TOTAL
Dubai	L	0.3							
TOTAL	L	40.3		L	16.5		L	1.6	L 58.4
	H	-		H	7.5		H	-	H 7.5
	All	40.3		All	24.0		All	1.6	All 65.9

SOURCE: Petroleum Compensation Board.

[a] L = light (density less than 900 kg/m^3)
H = heavy (density greater than 900 kg/m^3)

teristics of a potential refinery feedstock. They do, however, provide rough indications as to what the refined product yield and refining costs may be for a certain crude.

Due to the commingling of specific pool production with other pools tied into the same gathering system, the evaluation of feedstocks by pool is simply not a productive, let alone practical, undertaking. Based on the individual commingled pipeline streams outlined in Section 2.3, however, a clear picture of crude oil quality variations can be developed. These streams represent the entire range of domestic crudes currently available to refiners.

The density and sulphur characteristics of domestic and foreign crude streams are summarized in Table A.1. Based on these measures of crude oil quality, together with the estimated production from each stream relative to the total, weighted average crude oil specifications were calculated by computer for both domestic and foreign crude oil supplies.

The weighted average density and sulphur characteristics for domestic crude streams by province are illustrated in Figure 2.4.[9] On average, British Columbia and Alberta crudes are fairly light and sweet. In Alberta particularly, the dispersion of crude characteristics is very broad, ranging from light sweet Federated crude to heavy sour Lloydminster types. Manitoba crude is fairly light yet its sulphur content is significantly higher than Alberta. Saskatchewan crude is of relatively poor quality, characterized by a very high density and sulphur content.

The weighted average density and sulphur characteristics for selected foreign crude streams by country are illustrated in Figure 2.5.[10] With the exception of crude from the United Kingdom (North Sea), sulphur levels are high and quite similar. Of the two major suppliers, Saudi Arabian oil is of relatively good quality, whereas the average Venezuelan crude is quite heavy. For Mexico, the weighted average shown is based on a relatively large proportion of Isthmus crude. If the proportion of heavy Maya crude in Mexico's export blend

was greater, the density and sulphur levels illustrated could be considerably higher.

For pricing purposes, the Alberta Petroleum Marketing Commission (APMC) has defined 'par' crude oil in terms of density and sulphur levels. Any crudes with a density greater than 815 kg/m^3 or sulphur content in excess of 1.0 g/kg are subject to a price penalty which, in theory, represents compensation to the refiner for the economic penalties incurred running heavy, sour crude.

The relationship of this APMC 'benchmark' to the weighted average density and sulphur characteristics for domestic and foreign crudes is illustrated in Figure 2.6. Overall, domestic crudes are of significantly better quality than foreign crudes. Therefore, as domestic oil supplies decrease, they will be replaced by crudes with substantially poorer refining characteristics. Relative to both domestic and foreign crude qualities, the APMC par crude reflects a very low sulphur level and a marginally lower density.

If the price differentials based on quality accurately represent the relative value of different crude types, refiners should be indifferent as to the type of crude oil they run (barring any technical or product yield constraints). If the price differentials are not large enough, the refiners' preference will be for higher quality feedstocks that are less costly to refine and yield a more attractive product slate. On the other hand, if the price differentials are too large, the refiners' preference will be for lower quality feedstocks to take advantage of lower raw material costs. These price differentials are shown in Tables A.2 and A.3.

Crude oil pricing penalties decrease the oil price as the density or sulphur content increases. These penalties have not kept pace with general wellhead price increases or inflated operating costs incurred by refiners. Therefore, it is generally thought that these quality differentials are not large enough to adequately reflect the real economic cost of density and sulphur.

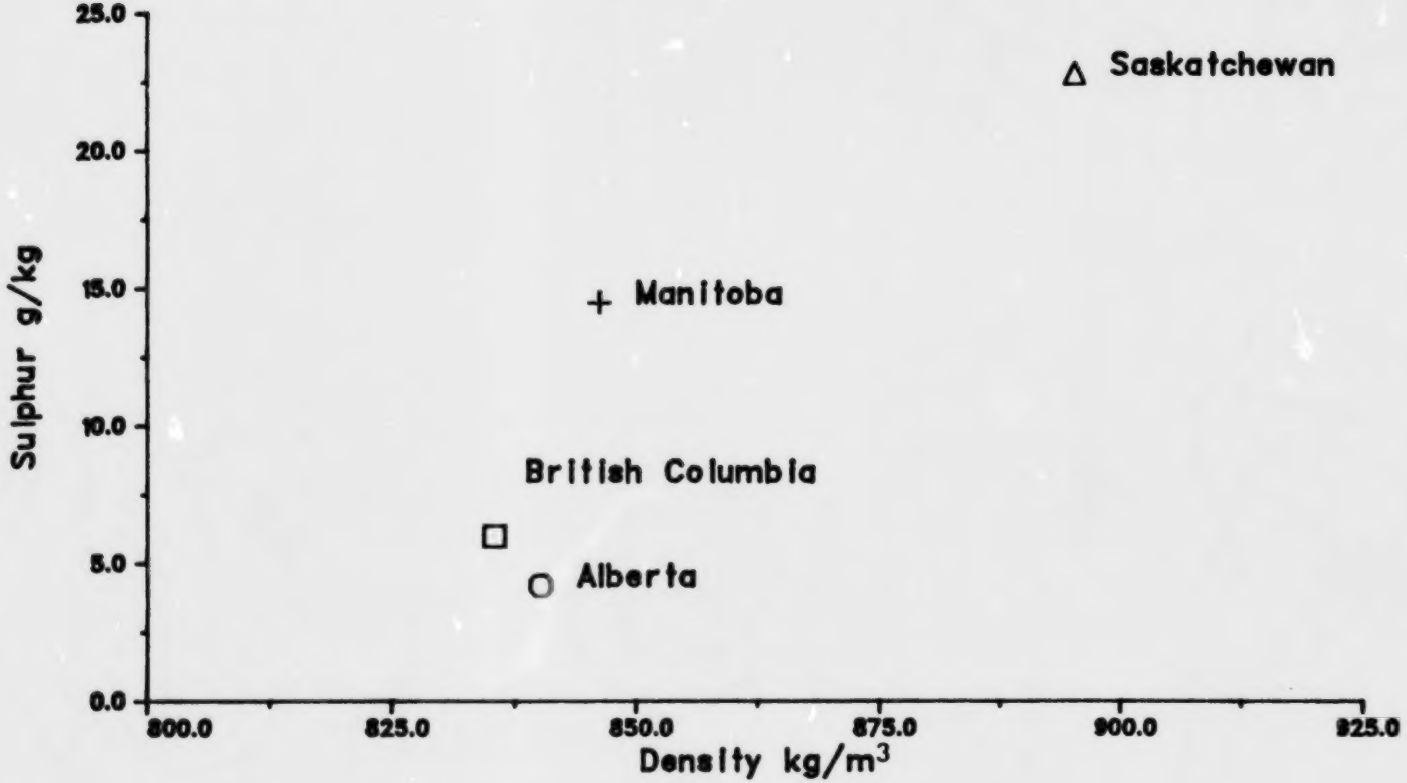


Figure 2.4: **Domestic Crude Oil Quality.**

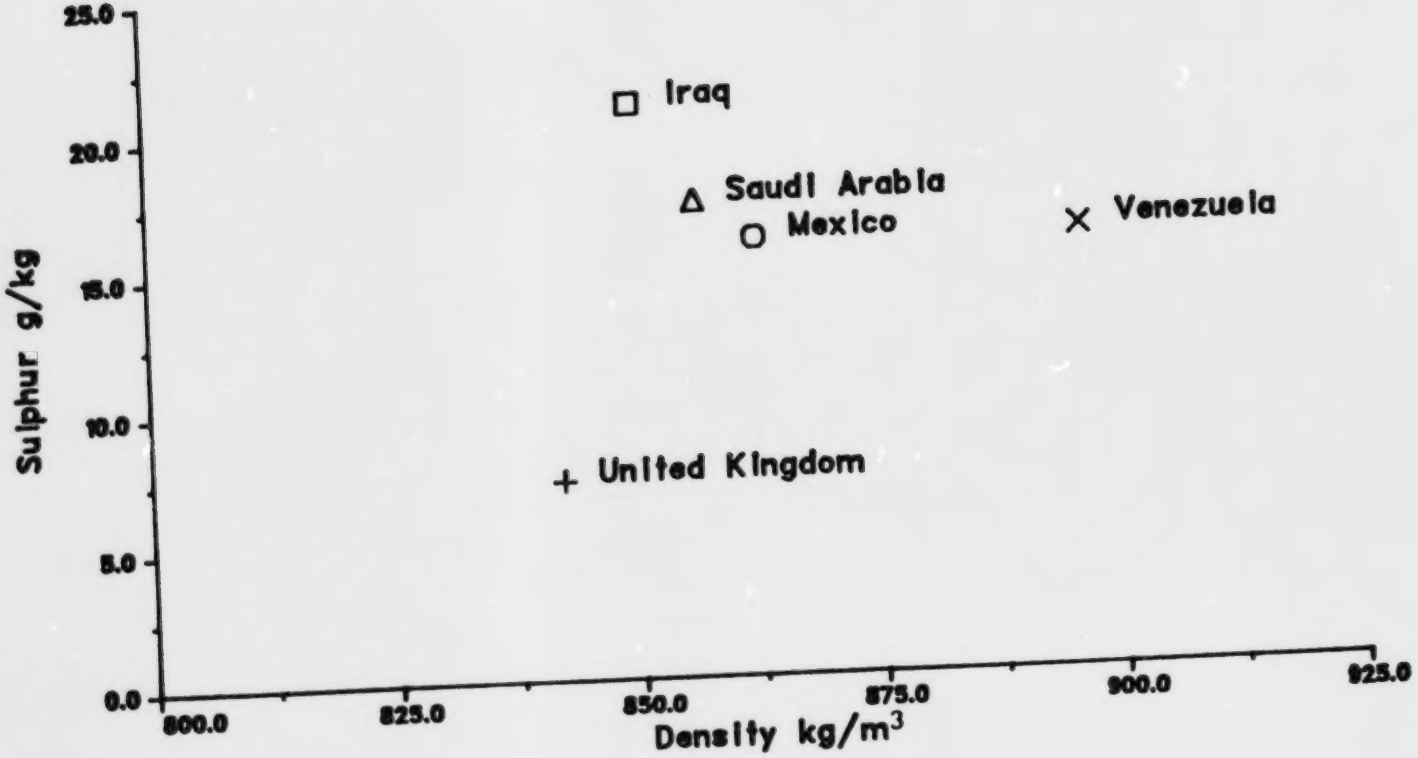


Figure 2.5: **Foreign Crude Oil Quality.**

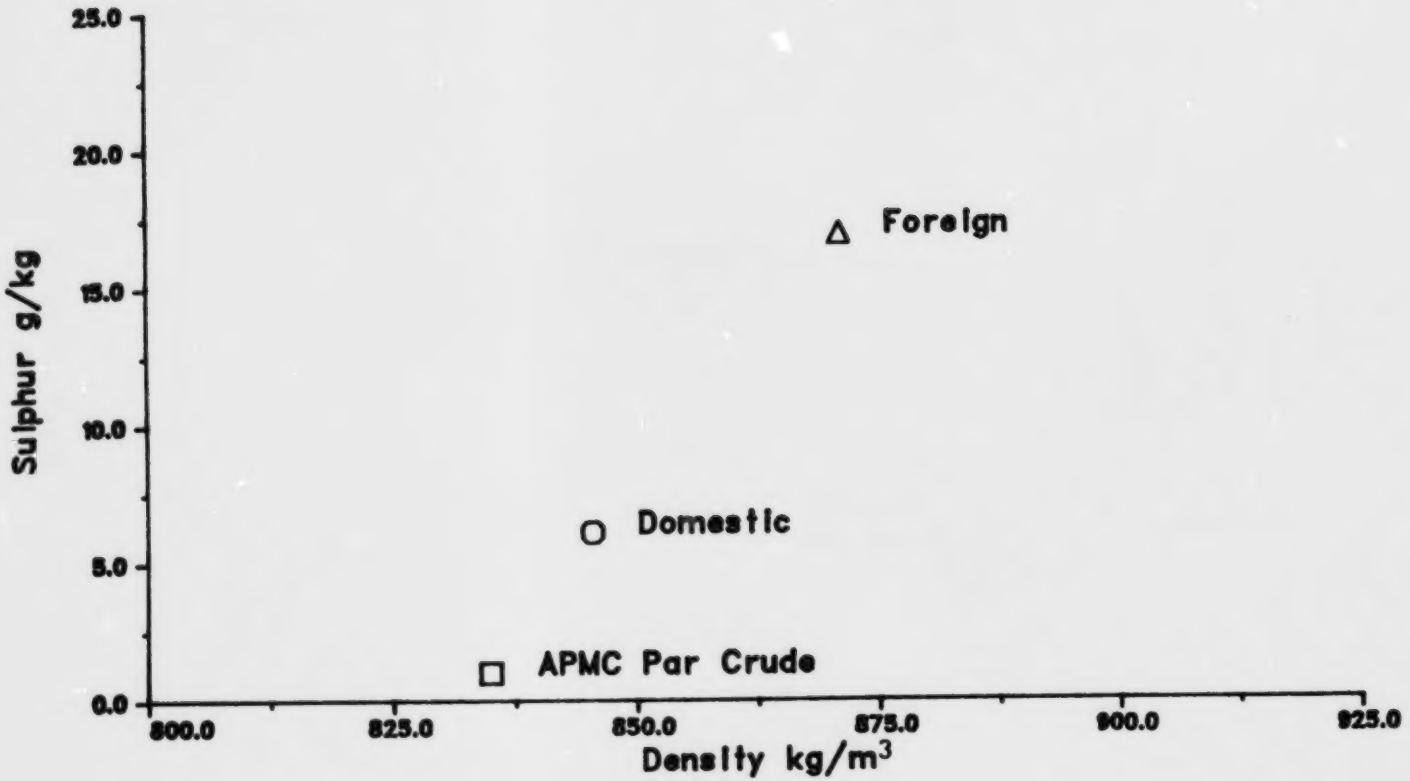


Figure 2.6: **Comparison of Domestic and Foreign Crude Oil Quality.**

The usual impact of density and sulphur levels on refining operations is illustrated in Figure 2.7. Simply stated, the cost of crude oil will decrease as the sulphur content increases. Hydrotreating costs for sulphur removal represent a small component of total operating costs. Gasoline usage requires that nearly all sulphur be removed, whereas the heavier middle distillates are permitted higher concentrations of sulphur compounds (therefore less costly hydrotreatment depending on the sulphur levels of particular fractions). Generally these costs are relatively minor and do not account for the sulphur pricing differential.

Where the primary effect of sulphur comes into play is in the manufacture of residual fuel oil. Heavier fractions have sulphur levels much greater than the average sulphur level of the crude oil. Large amounts of middle distillate (known as cutback) are added to residual materials in order to blend down the sulphur level for the final residual fuel oil. This diversion of middle distillates to the residual fuel oil 'pool' alters the final product slate by utilizing the more valuable distillates for the production of residual fuel oil. As the sulphur content of crude increases, increasingly larger proportions of cutback are required to reduce the sulphur content of final residual fuel oil. As a result, the value of the product slate declines as the sulphur level of crude increases, and the refining margin becomes an inverse function of the sulphur content. Refiners will therefore maximize economic returns by running low sulphur feedstocks.

Similarly the impact of density will affect the net value received from a barrel of crude. Refining costs increase as the density increases, for it becomes necessary to upgrade the increasingly larger heavy fractions into lighter products (notably cracked gasoline). In addition the product yield may shift from higher value light products to lower value heavy products. Together the net effect will be a reduction in refining margin as the density increases.[11]

A refinery may be able to maintain its product yield (and therefore total revenue) by more extensive utilization of the heavy fuel oil conversion capability of the plant.[12] Refining costs will

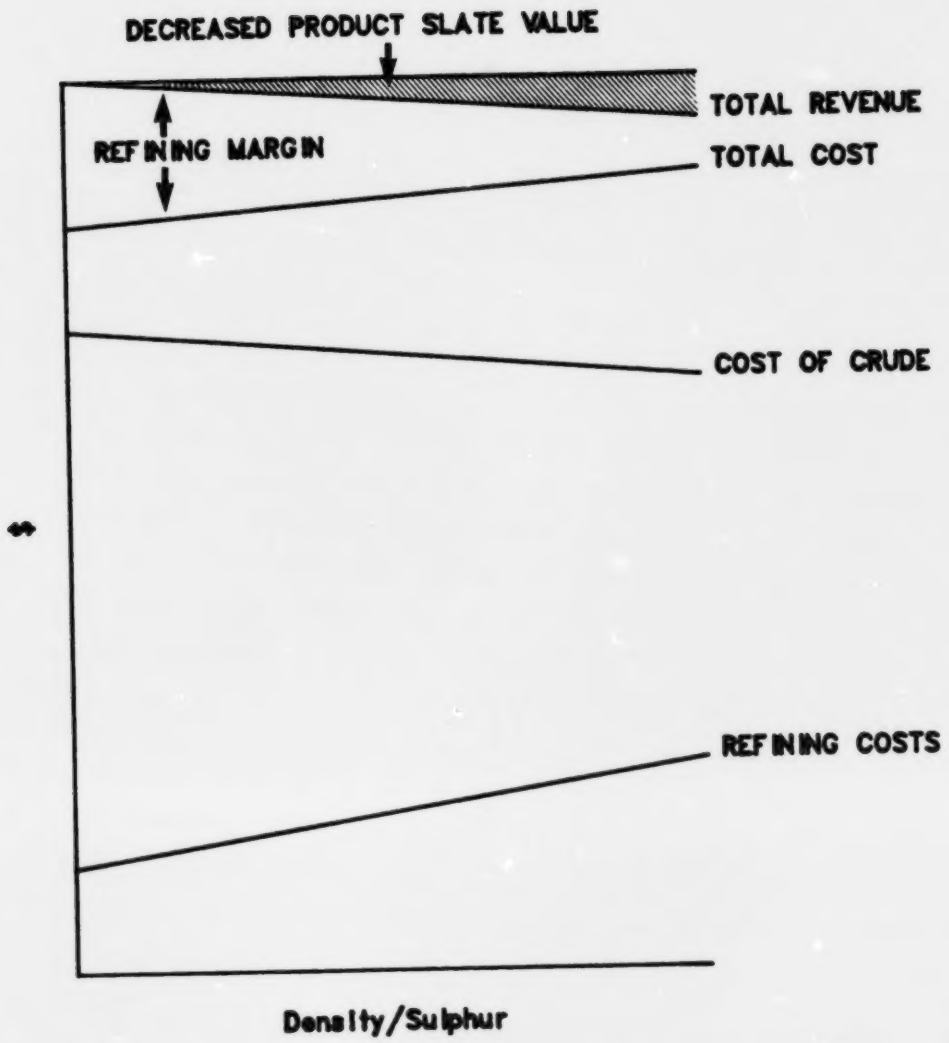


FIGURE 2.7: Effects of Density and Sulphur on Refining Margin.

increase, however, and there will be a trade off between the incremental revenue generated from upgrading and the incremental costs of operating these upgrading facilities.

In any event, refiners recognize that the price penalties for density are generally not great enough to compensate for the associated decreased revenues and increased refining costs. Therefore, refining margins will be maximized by running as large a proportion of light sweet crude oil as possible.

2.5 Supply Forecast

The preceding sections of this chapter illustrate that crude oil supplies available to Canadian refiners vary significantly in terms of the five supply criteria discussed earlier. Since the crude types available to refiners vary in terms of security, longevity, quality, transportability and economy, it is essential that future crude oil availability be discussed not only in terms of aggregate supply, but also with regard to specific crude oil sources and types.

The supply forecast developed herein recognizes the inherent element of uncertainty involved in the forecasting procedure. Three cases have been developed to illustrate the potential range of supply scenarios rather than to identify a single, most likely, case. The forecast years are 1981, 1985, 1990, 1995 and 2000. Future productive capacity is classified into the following major categories.

- Established Reserves
  Production, by specific pipeline stream, from currently proven reserves.

- Extensions and Discoveries
  Production, by province, from additions to established reserves and non-frontier discoveries.

- Tertiary
  Production, by province, through enhanced recovery methods.

- Pentanes Plus

  Production, by province, from currently proven reserves and additions.

- Synthetic

  Production, by province, of synthetic crude from mining or in situ oil sands projects, and the production from heavy crude oil upgraders.

- Frontier

  Production, in total, from frontier regions.

These six categories of productive capacity, in aggregate, represent the entire indigenous supply of crude oil available to domestic refiners. It has been assumed that any excess domestic demand will be satisfied through foreign crude oil imports.

The quality characteristics of crude oil from established reserves were documented by pipeline stream, as discussed in Section 2.4 of this paper. Synthetic oil production was assumed to be technically similar in nature, simply because the characteristics of synthetic oil from future tar sands plants is still not certain. Therefore, quality characteristics were assumed to be the same for all synthetic oil. Production from extensions and discoveries, tertiary recovery, frontier sources, and pentanes plus were not forecast by specific stream, however. Characteristics of these sources were equated with a representative crude stream in that province.

The three supply scenarios were derived from data from published sources and represent different underlying assumptions and perceptions of the future. The low, base and high case supply forecast descriptions are compared in Table 2.6. For production from established reserves, extensions and discoveries, tertiary recovery, pentanes plus, and oil sands to 1990, the high and low case forecasts represent symmetrical variations above and below the base case. These cases represent the inherent uncertainty in the base case production scenario.

Tertiary recovery, oil sands, upgraded heavy, and frontier estimates vary quite considerably from the low case to the high case.

TABLE 2.6

CRUDE OIL SUPPLY SCENARIOS

Category	Low Case	Base Case	High Case
Established Reserves	Base case - 10%	CPA only to 1990 forecast of crude oil productive capacity	Base case + 10%
Extensions and Discoveries	Base case - 10% to 1990 Base case - 30% to 2000	Modified CPA forecast to 1990 Modified 1980 industry forecast to 2000	Base case + 10% to 1990 Base case + 30% to 2000
Tertiary	Base case - 10% to 1990 Base case - 30% to 2000	Modified CPA forecast to 1990 Modified industry forecast to 2000	Base case + 10% to 1990 Base case + 30% to 2000
Pentanes Plus	Base case - 10%	CPA forecast to 1990 Trend line to 2000	Base case + 10%
Oil Sands	Base case - 10% to 1990 Flat to 2000	NEB 1978 base case forecast 100,000 m^3/d in 1995 120,000 m^3/d in 2000	Base case + 10% to 1990 120,000 m^3/d in 1995 160,000 m^3/d in 2000
Upgraded Heavy	No production in 1990 8,000 m /d in 1995 8,000 m /d in 2000	8,000 m^3/d in 1990 16,000 m^3/d in 1995 16,000 m^3/d in 2000	16,000 m^3/d in 1990 24,000 m^3/d in 1995 24,000 m^3/d in 2000
Frontier	No production	10,000 m^3/d in 1995 50,000 m^3/d in 2000	80,000 m^3/d in 1995 80,000 m^3/d in 2000

The primary reason for these variances is price uncertainty (except in the frontier where exploration success will also play a major role). Estimates indicate that the supply price for crude from these sources is quite high vis-a-vis conventional oil.[13] Therefore, inadequate price incentives will limit the economic viability of many development proposals. It must be emphasized, however, that price is not the only criterion in developing these supply cases. Political climate, economic conditions, exploration successes, etc., will all have an effect.

The low case oil sands forecast assumes no new oil sands plants after Alsands and Cold Lake. The base case oil sands forecast assumes a Syncrude expansion around 1985 and that the Petro-Canada/Nova plant and one other 22,000 m^3/d plant will proceed by the end of the century. The high case assumes all of the above plus two more plants by the year 2000. (This high case appears very optimistic.) In all cases, total potential production will not be fully achieved by 2000 due to normal delays in plant start-up.

The low case upgraded heavy oil forecast assumes one 8 000 m^3/d plant by 1995. The base case assumes one by 1990, and another by 1995. The high case assumes two by 1990, and another by 1995.

The low case frontier forecast assumes no frontier production in the forecast period. The base case assumes frontier production beginning in 1995 at low levels, and not increasing to full potential until after 2000. The high case assumes full frontier potential of 80,000 m^3/d in 1995.

The detailed low, base and high case supply forecasts by stream for each forecast year are shown in Appendix Tables A.4, A.5 and A.6, respectively. These values are combined in Chapter 4 with demand estimates in order to develop supply/demand matrices showing detailed oil usage by region.

Figure 2.8 illustrates aggregate low, base and high case supply forecasts based on values from Appendix A. Only a relatively minor variance on either side of the base case is shown to 1990. Thereafter,

the divergence is extreme with the high case supply exceeding low case supply by a ratio greater than 2 to 1 by the year 2000.

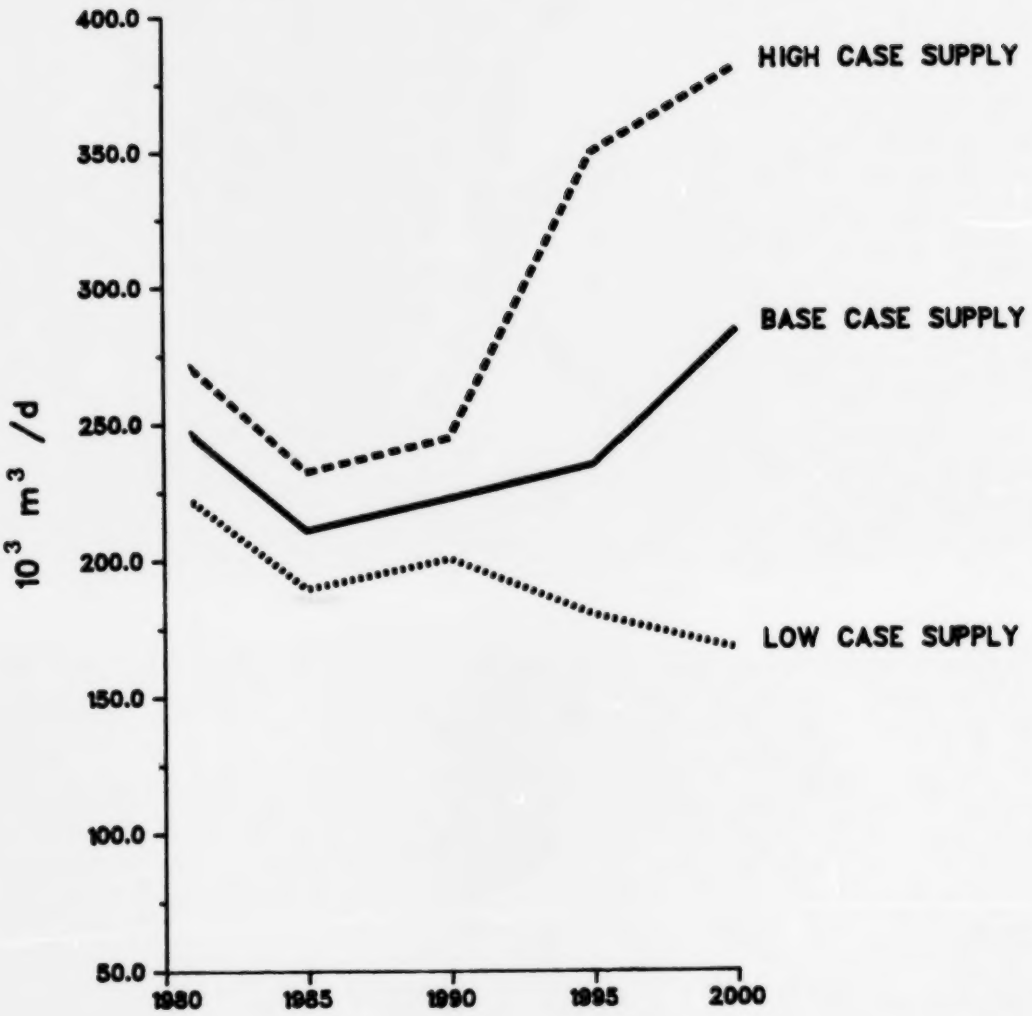


Figure 2.8: Crude Oil Supply Scenarios.

Footnotes

[1]Canada, Statistics Canada, Refined Petroleum Products (Ottawa: Supply and Services), Catalogue No. 45-004, June 1980.

[2]Based on a wellhead price of about $\$93/m^3$ for the first half of 1980, and foreign oil prices of about $\$180/m^3$ for the same period.

[3]Canada, Department of Energy, Mines and Resources, An Energy Strategy for Canada: Policies for Self-Reliance. (Ottawa: Minister of Supply and Services Canada), 1976. Self-reliance was defined as the limitation of oil imports to one-third of total domestic requirements. Self-sufficiency, defined as a net import dependence of zero, is the new goal of the federal government. See, Canada, Department of Energy, Mines and Resources, The National Energy Program (Ottawa: Minister of Supply and Services Canada), 1980.

[4]Crude oil supply scenarios will be developed more fully later in Chapter 2, and oil demand scenarios will be developed in Chapter 3.

[5]Canada, Statistics Canada, Refined Petroleum Products. (Ottawa: Supply and Services), Catalogue No. 45-004, September 1980.

[6]Prior to 1960, the productive capacity of western Canadian crude oil had increased dramatically. Due to higher lifting costs, however, western Canadian oil met with sharp price competition from foreign crude in eastern Canadian markets. This led to shut-in production. In an effort to provide a market for western Canadian oil, the federal government introduced a policy whereby Quebec and the Atlantic would remain dependent on foreign oil, and refiners west of the Ottawa Valley would use domestic crude.

[7]The only major change envisioned for this gathering system network in the near future is the possibility of a pipeline link between the Norman Wells field and the most northern extremity of the Rainbow system. This pipeline will transport about 4 000 m^3/d of incremental Norman Wells production to Edmonton.

[8]From an address to the Canadian Society for Chemical Engineering by J. P. Gallagher, entitled Security of Energy Supply for Canada. Edmonton, October 20, 1980.

[9]Based on 1980 crude oil production forecast from Canada, National Energy Board, Canadian Oil Supply and Requirements (Ottawa: National Energy Board), September 1978.

[10]Based on 1980 crude oil import data from the Petroleum Compensation Board.

[11]Preliminary results from a forthcoming MA thesis by S. Streifel indicate that sulphur and density price differentials are inadequate to compensate refiners for the actual costs of processing different grades of crude. Results indicated an increase in density and sulphur penalties of at least 100% would be required.

[12]Given heavier refinery feedstock, product yield can be maintained through additional processing of the heavy end of the barrel. Cracking units are expensive to install and operate, and perform the function of upgrading heavy streams from distillation units into more valuable gasoline and distillates.

[13]Z. Charles Slagorsky, "Alternative Future Supplies of Oil in Canada and Their Costs" (Calgary: Canadian Energy Research Institute, May 1980), Working Paper 80-3. Also, see J. A. Dawson, and Z. C. Slagorsky, Benefits and Costs of Oil Self-Sufficiency in Canada, (Calgary: Canadian Energy Research Institute, February 1981), Study No. 12.

Chapter 3

REFINED PETROLEUM PRODUCT DEMAND

The primary task of the petroleum industry is to meet the energy demands of consumers. In the case of oil based products, this demand is not for crude oil per se, but for the wide range of refined products that can be manufactured from the oil.

Therefore, the refinery demand for crude oil is a direct function of consumer demands for refined petroleum products (RPP). This relationship is twofold. First, the magnitude of RPP demand directly defines the magnitude of crude oil demand, within a relatively narrow range of inventory flexibility. Second, the specific makeup of RPP demand directly affects the specific types of crude oil demanded by a refiner. For example, if RPP demand is concentrated around the light end of the oil product mix, in general refiners will correspondingly demand lighter crude types.

This chapter presents an analysis of the main elements of RPP demand. Product yields and production trends are discussed, and a forecast of specific RPP demand by region is developed. The chapter concludes with a regional crude oil forecast derived from the RPP demand analysis.

3.1 Product Slate

The end use of refined petroleum products generally falls into one of four categories. Broadly defined, these major groups cover the full spectrum of petroleum product uses. The categories are:

- transportation fuel;
- heating fuel;
- petrochemical feedstock; and
- non-energy.

Transportation uses include road (both automobile and truck), air, rail, and marine fuel. Heating fuel uses encompass residential, commercial and industrial heating, and may include generation of energy other than heat (such as electricity). Petrochemical feedstocks are used in the manufacture of petroleum-based chemicals such as ethylene, polypropylene, etc. Non-energy uses include machinery lubrication, road paving, etc.

The slate of products manufactured by Canadian refineries is broad. For classification purposes, these products may be listed as follows:[1]

gases	stillgas propane butane
light distillates	petrochemical feedstock naphtha aviation gasoline motor gasoline
middle distillates	aviation fuel kerosene (No. 1) diesel light fuel oil (No. 2,3)
residue	heavy fuel oil (No. 4,5,6) asphalt coke lubricating oil & grease

Table 3.1 is a matrix illustrating the major end uses of petroleum products refined in Canada. In general, light distillates go to transportation and petrochemical uses. Middle distillates primarily serve transportation and heating fuel demands and residue is used principally in heating and non-energy uses such as industrial boiler fuel and asphalt, respectively. These major end uses are summarized in Table 3.2.

TABLE 3.1

END USE OF REFINED PETROLEUM PRODUCTS

Product	Transportation				Heating			Petro-chemical	Non-energy
	Road	Air	Rail	Marine	Residential	Commercial	Industrial		
Stillgas							X		
Propane	X				X	X	X	X	
Butane						X	X	X	
Petrochemical feedstocks								X	
Naphtha								X	
Aviation gasoline		X							
Motor gasoline	X								
Aviation fuel		X							
Kerosene					X	X	X		
Diesel	X		X	X					
Light fuel oil					X	X	X		
Heavy fuel oil				X			X		X
Asphalt									X
Coke							X		X
Luboil									

TABLE 3.2

MAJOR END USE BY PETROLEUM PRODUCT GROUP

Petroleum Product Group	Primary End Use
Light Distillates	Petrochemical Transportation
Middle Distillates	Transportation Heating
Residue	Heating Non-Energy

It is important to note that not all refineries in all regions produce the wide product slate discussed here. Table 3.3 summarizes the range of petroleum products produced by region. British Columbia, Alberta, Ontario and Quebec all produce a full product array. The Northwest Territories produces mainly transportation and heating fuels, while Saskatchewan, Manitoba and the Atlantic do not manufacture certain specific products such as aviation gasoline and naphtha specialties.

This regional variation in refined petroleum product slates is due in part to the regional demand patterns exhibited, as well as the physical characteristics of refineries. Given that the refining and blending process (subject to physical constraints) may be adjusted to meet product demands, a certain product per se may not be produced in a specific region.

3.2 Product Yield

The yield of refined petroleum products varies significantly by region. This variance is exhibited in both absolute terms (the magnitude of total demand) and in relative terms (demands for specific products). Table 3.4 summarizes petroleum product production by region. In total, Ontario and Quebec are the largest manufacturers of

TABLE 3.3

PETROLEUM PRODUCT SLATE BY REGION
(X indicates product not manufactured.)

Product	Region							
	N.W.T.	B.C.	Alta.	Sask.	Man.	Ont.	Que.	Atlan.
Stillgas								
Propane	X							
Butane	X							
Petrochemical	X			X	X			
Naphtha	X			X	X			X
Aviation gasoline				X	X			
Motor gasoline								
Aviation fuel				X				
Kerosene	X							
Diesel								
Light fuel oil				X				
Heavy fuel oil								
Asphalt	X							
Coke	X							
Luboil	X			X	X			

SOURCE: Canada, Statistics Canada, Refined Petroleum Products (Ottawa: Supply and Services), Catalogue No. 45-004.

petroleum products in Canada, followed in order by the Atlantic provinces, Alberta, British Columbia, Saskatchewan, Manitoba and the Northwest Territories.

These disproportionate product yields are illustrated in Table 3.5. Certain patterns are evident. The 'total' row represents the percentage each region makes up of total Canadian refined petroleum product production. If individual product percentages for a specific region vary significantly from this total percentage, this indicates an aberration that can be explained by circumstances particular to a certain region. Ontario is the disproportionate leader in petrochemical feedstock and naphtha production, undoubtedly to meet the strong demand of the petrochemical industry in Ontario. Quebec produces more than its share of light fuel oil and asphalt. The main reasons are the lack of natural gas penetration in the Quebec market and the relatively heavier feedstocks Quebec refiners utilize. Alberta and British Columbia refiners produce a disproportionately high amount of transportation fuels. In part, this can be explained by a strong interregional demand for Alberta manufactured gasoline and diesel. The Atlantic region accounts for a large proportion of both light and heavy fuel oil production. As with Quebec, home heating demand would be one reason, as well as a lack of heavy fuel oil upgrading capability.

Table 3.6 illustrates product yields by region as a percentage of total production by region. For all of Canada, by far the largest part of the refined barrel (fully one third) goes to gasoline. That proportion can vary from over one half in Manitoba to less than one quarter in the Atlantic. Diesel makes up a particularly large part of the refined barrel in Alberta and British Columbia (almost 30 percent). Light and heavy fuel oil together dominate the refined barrel in Ontario, Quebec and the Atlantic provinces (30.4 percent in Ontario to 53.4 percent in the Atlantic). It should be emphasized that these yields are a function of both product demand and refinery flexibility.

In the short term, demand shifts and refinery flexibility are best illustrated by seasonal swings in refined product production.

TABLE 3.4

REGIONAL REFINED PETROLEUM PRODUCT PRODUCTION, 1979
($10^3 m^3$)

Product	Canada	Atlantic	Quebec	Ontario	Manitoba	Sask.	Alberta	B.C.	N.W.T.
Stillgas	3 972.1	607.6	990.6	1 491.4	67.8	95.5	357.3	356.7	5.2
C3 mix	1 546.5	184.2	377.6	523.5	14.8	29.8	304.5	112.1	0.0
C4 mix	902.2	212.1	159.9	267.7	11.3	72.2	109.2	69.8	0.0
Petrochemical	5 739.0	138.5	1 441.7	4 108.1	0.0	0.0	4.3	46.4	0.0
Naphtha	670.8	0.1	81.8	547.1	0.7	0.0	23.6	17.5	0.0
Aviation gasoline	249.9	0.0	99.2	12.7	0.0	0.0	129.7	8.7	-0.4
Motor gasoline	38 261.9	4 381.9	9 105.1	11 490.6	910.0	954.6	7 429.2	3 964.8	25.7
Aviation fuel	4 909.4	544.7	1 253.1	1 280.8	32.2	0.0	1 132.9	660.2	5.5
Kerosene	3 973.8	572.9	1 024.3	1 289.2	161.6	453.7	58.4	413.7	0.0
Diesel	14 818.1	1 575.1	2 274.8	2 987.6	271.5	212.5	4 820.2	2 651.9	24.5
Light fuel oil	14 545.7	4 199.7	5 462.5	4 710.4	14.5	0.0	9.2	124.1	25.3
Heavy fuel oil	19 928.6	5 739.7	5 927.7	6 059.6	92.7	26.5	1 020.7	1 037.2	24.5
Asphalt	3 377.8	288.5	1 301.6	376.9	108.2	193.2	820.0	289.4	0.0
Coke	819.3	86.1	127.4	271.2	24.8	14.4	253.9	41.5	0.0
Luboil	858.0	3.8	252.8	420.2	0.0	0.0	178.9	2.3	0.0
Other	109.8	81.8	-120.2	-457.1	3.0	325.1	293.0	-14.0	-1.8
Total	114 682.9	18 616.7	29 759.9	35 379.9	1 713.1	2 377.5	16 945.0	9 782.3	108.5

SOURCE: Canada, Statistics Canada, Refined Petroleum Products (Ottawa: Supply and Services), Catalogue No. 45-004.

TABLE 3.5

REGIONAL REFINED PETROLEUM PRODUCT PRODUCTION, 1979
(Percent of Canadian Production)

Product	Canada	Atlantic	Quebec	Ontario	Manitoba	Sask.	Alberta	B.C.	N.W.T.
Stillgas	100.0	15.3	24.9	37.6	1.7	2.4	9.0	9.0	0.1
C3 mix	100.0	11.9	24.4	33.9	1.0	1.9	19.7	7.2	0.0
C4 mix	100.0	23.5	17.7	29.7	1.3	8.0	12.1	7.7	0.0
Petrochemical	100.0	2.4	25.1	71.6	0.0	0.0	0.1	0.8	0.0
Naphtha	100.0	0.0	12.2	81.6	0.1	0.0	3.5	2.6	0.0
Aviation gasoline	100.0	0.0	39.7	5.1	0.0	0.0	51.9	3.5	0.2
Motor gasoline	100.0	11.4	23.8	30.0	2.4	2.5	19.4	10.4	0.1
Aviation fuel	100.0	11.1	25.5	26.1	0.7	0.0	23.1	13.4	0.1
Kerosene	100.0	14.4	25.8	32.4	4.1	11.4	1.5	10.4	0.0
Diesel	100.0	10.6	15.4	20.2	1.8	1.4	32.5	17.9	0.2
Light fuel oil	100.0	28.9	37.5	32.4	0.1	0.0	0.1	0.8	0.2
Heavy fuel oil	100.0	28.8	29.8	30.4	0.5	0.1	5.1	5.2	0.1
Asphalt	100.0	8.5	38.5	11.2	3.2	5.7	24.3	8.6	0.0
Coke	100.0	10.5	15.5	33.1	3.0	1.8	31.0	5.1	0.0
Luboil	100.0	0.4	29.5	49.0	0.0	0.0	20.8	0.3	0.0
Other	100.0	74.5	-109.5	-416.3	2.7	296.1	266.8	-12.7	-1.6
Total	100.0	16.2	25.9	30.9	1.5	2.1	14.8	8.5	0.1

SOURCE: Table 3.4

TABLE 3.6

REGIONAL REFINED PETROLEUM PRODUCT PRODUCTION, 1979
(Percent of Total Refinery Yield)

Product	Canada	Atlantic	Quebec	Ontario	Manitoba	Sask.	Alberta	B.C.	N.W.T.
Stillgas	3.5	3.3	3.3	4.2	4.0	4.0	2.1	3.7	4.8
C3 mix	1.3	1.0	1.3	1.5	0.9	1.3	1.8	1.1	0.0
C4 mix	0.8	1.1	0.5	0.8	0.7	3.0	0.6	0.7	0.0
Petrochemical	5.0	0.7	4.8	11.6	0.0	0.0	0.0	0.5	0.0
Naphtha	0.6	0.0	0.3	1.6	0.0	0.0	0.1	0.2	0.0
Aviation gasoline	0.2	0.0	0.3	0.0	0.0	0.0	0.8	0.1	-0.4
Motor gasoline	33.4	23.5	30.6	32.5	53.1	40.2	43.8	40.5	23.7
Aviation fuel	4.3	2.9	4.2	3.6	1.9	0.0	6.7	6.7	5.1
Kerosene	3.5	3.1	3.4	3.6	9.4	19.1	0.4	4.2	0.0
Diesel	12.9	8.5	7.7	8.4	15.9	8.9	28.5	27.1	22.6
Light fuel oil	12.7	22.6	18.4	13.3	0.8	0.0	0.1	1.3	23.3
Heavy fuel oil	17.4	30.8	19.9	17.1	5.4	1.1	6.0	10.6	22.6
Asphalt	2.9	1.6	4.4	1.1	6.3	8.1	4.8	3.0	0.0
Coke	0.7	0.5	0.4	0.8	1.4	0.6	1.5	0.4	0.0
Luboil	0.7	0.0	0.9	1.2	0.0	0.0	1.1	0.0	0.0
Other	0.1	0.4	-0.4	-1.3	0.2	13.7	1.7	-0.1	-1.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

SOURCE: Table 3.4

Figure 3.1 illustrates the refining response to swings between winter demand in the first quarter and summer demand in the third quarter. The line at 25 percent indicates the expected production if petroleum products were demanded uniformly throughout the year. The bars plotting first and third quarter production show the swings above or below the 25 percent norm and thus the associated refinery production adjustments.

The largest swing in seasonal production is in asphalt, with the very high demands of the third quarter summer paving season yielding to very minor cold weather demand in the first quarter. Butane production is significantly below the norm during the first quarter, primarily due to the use of butane for blending in winter gasoline supplies. Light fuel oil production is relatively high during the first quarter in response to demands for winter heating. All transportation fuel production is marginally lower in the first quarter as eastern refiners shift emphasis to heating fuel production.

It is interesting to note that for Canada in total, the quarterly production of gasoline remains relatively constant. Figure 3.2 illustrates quarterly motor gasoline production variations by region. For the major refining regions, production is moderate in the first quarter and then falls off slightly in the second quarter. Third quarter production is above the 25 percent norm in response to summer driving demands. Production then flattens in the fourth quarter. Saskatchewan and the Northwest Territories exhibit the same general trend, but the quarterly swings are much more pronounced.

3.3 Production Trends

Recent trends in total refined petroleum product output are illustrated in Figure 3.3. Production in Canada has increased significantly since 1973, with all regions except Quebec having increasing or stable levels of output through this period. Ontario has shown the sharpest production increases, followed by Alberta. These trends are expected to change, with Ontario growth moderating, and Alberta growth accelerating.

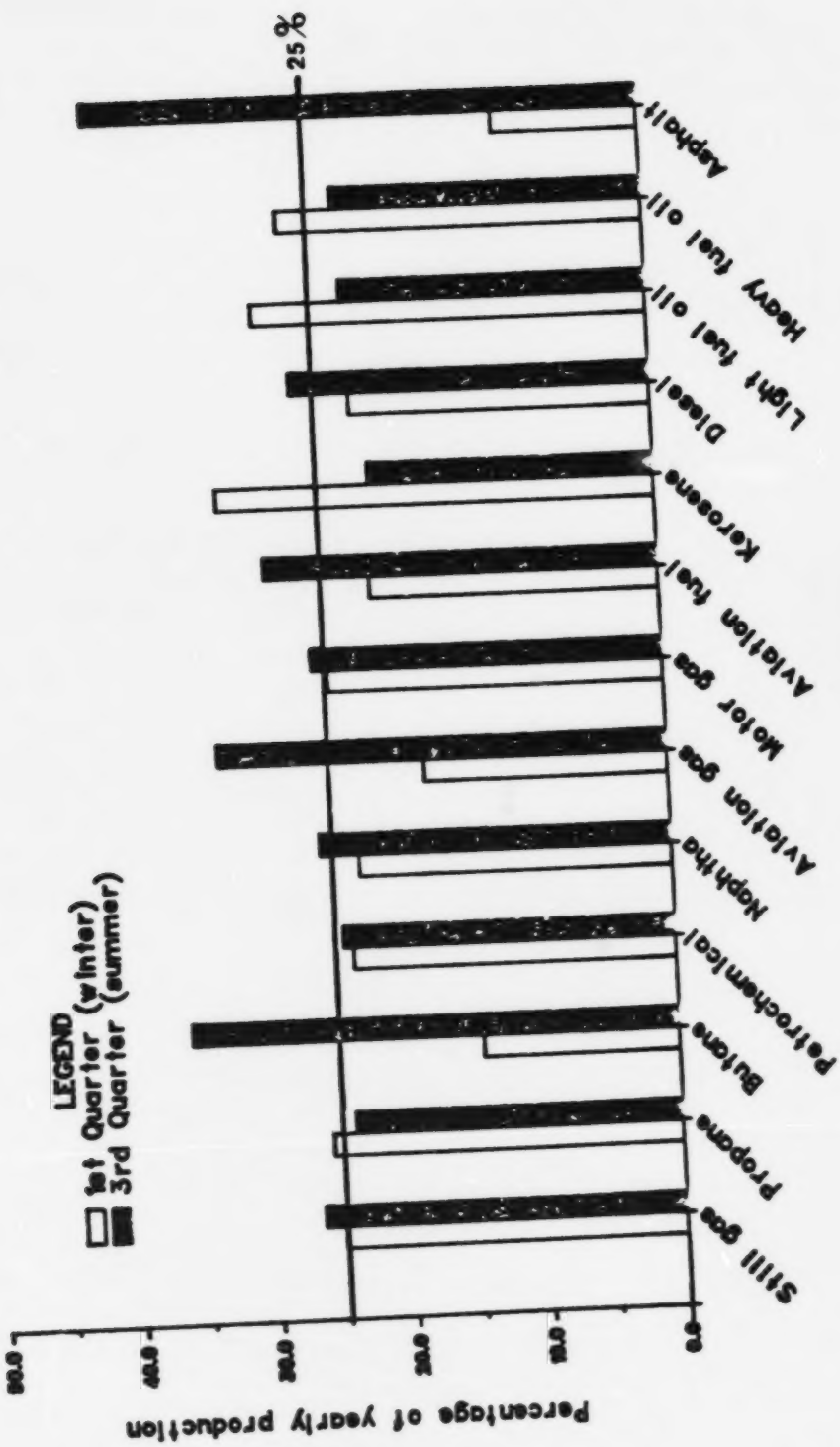


FIGURE 3.1: Quarterly Refined Petroleum Product Production Variation.
SOURCE: Statistics Canada. Catalogue No. 45-004

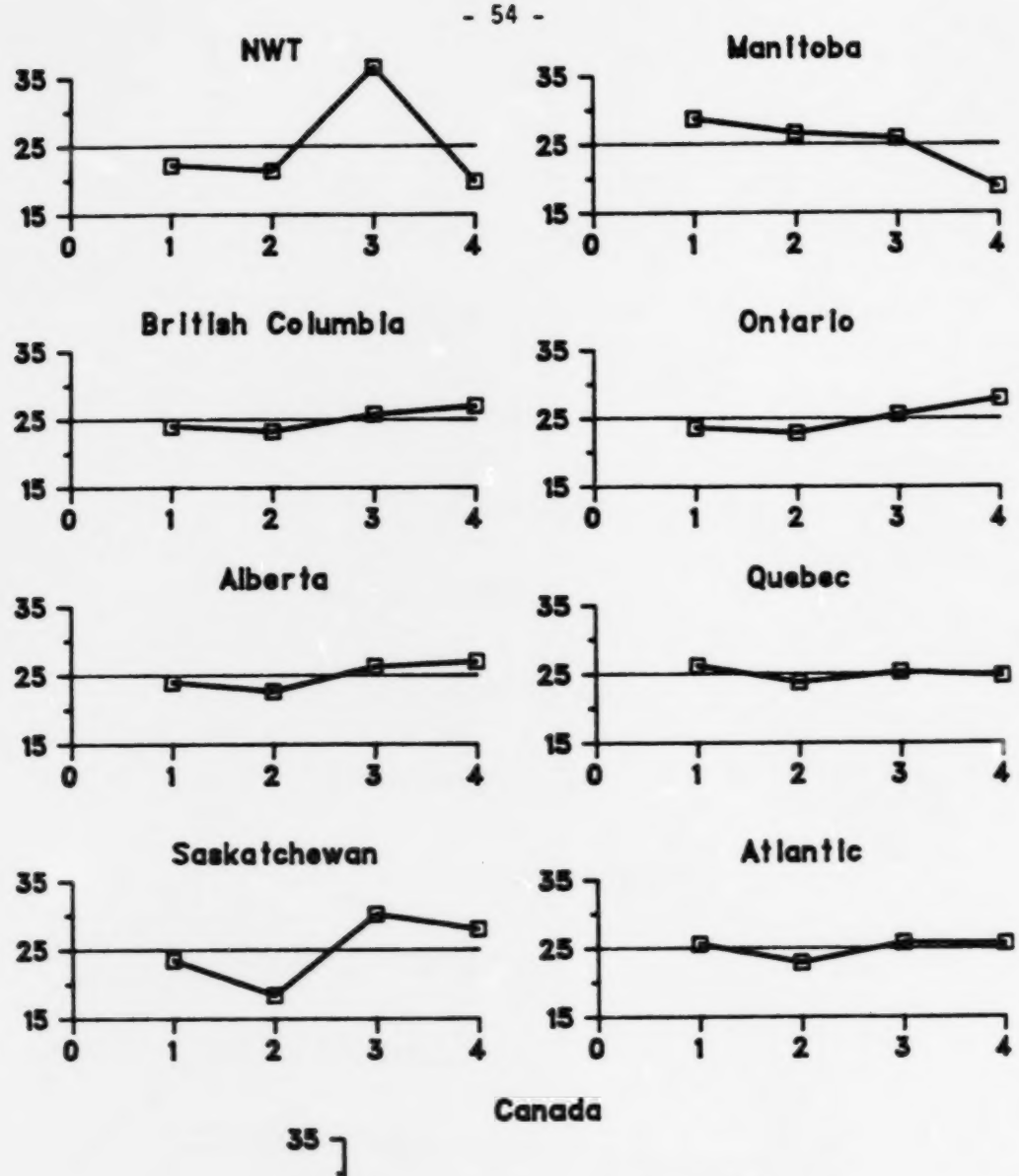


FIGURE 3.2: Quarterly Motor Gasoline Production Variations. 1979
SOURCE: Statistics Canada. Catalogue No. 45-004

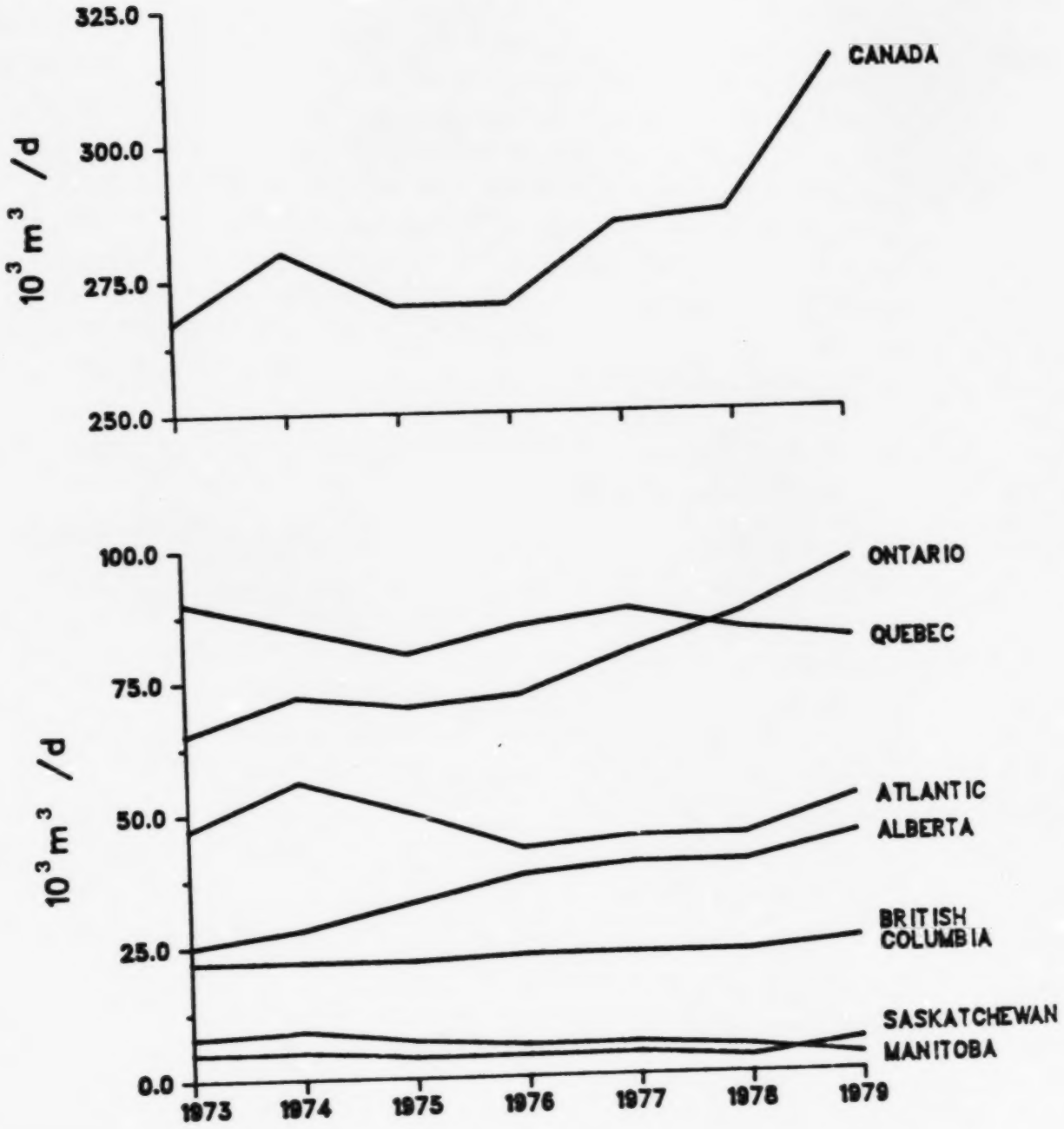


FIGURE 3.3: Total Refined Petroleum Product Production 1973 – 1979.
SOURCE: Statistics Canada. Catalogue No. 45 – 004.

On a product-specific basis for Canada, the relative yield of the major refined products has not changed a great deal. This is illustrated in Figure 3.4. Nevertheless, the direction of change is of interest. The relative share of the refined barrel that goes to transportation fuels increased from about 48 percent of the barrel in 1973 to about 51 percent in 1979. Petrochemical feedstocks rose from 2 percent of the refined barrel in 1973 to 5 percent in 1979, reflecting the increased importance of the Ontario petrochemical industry. The relative yield of light and heavy fuel oil fell from 36 percent of the barrel in 1973 to 30 percent in 1979, primarily due to substitution for alternate fuels such as natural gas.

3.4 Capacity and Utilization

A delineation of the crude oil refining capacity in Canada reveals two basic facts. First, there is a large under-utilization of capacity in Ontario, Quebec and the Atlantic. Second, the western provinces are at nameplate capacity. Figure 3.5 illustrates this situation. In total, slightly more than three quarters of the refining capacity in eastern Canada is being utilized. Refined petroleum product demand projections indicate that additional capacity will be required in western Canada.

3.5 Demand Forecast

The preceding sections of this chapter provide a descriptive background related to refined petroleum product demand. In this section, three demand scenarios are developed based on this information.

Given that the ultimate objective of this chapter is to develop a representative range of refined petroleum product demand scenarios, it was decided to start from a linear base forecast of aggregate crude oil demand for Canada, rather than from separate forecasts of demand for specific refined petroleum products. Symmetrical high and low case scenarios were formulated based on perceptions regarding the extent of demand fluctuation on each side of the base case. Since there is no concensus regarding future oil demand, it was felt that a

FIGURE 3.4: Changes in Refined Petroleum Product Yield. 1973 – 1979.
SOURCE: Statistics Canada. Catalogue No. 45–004.

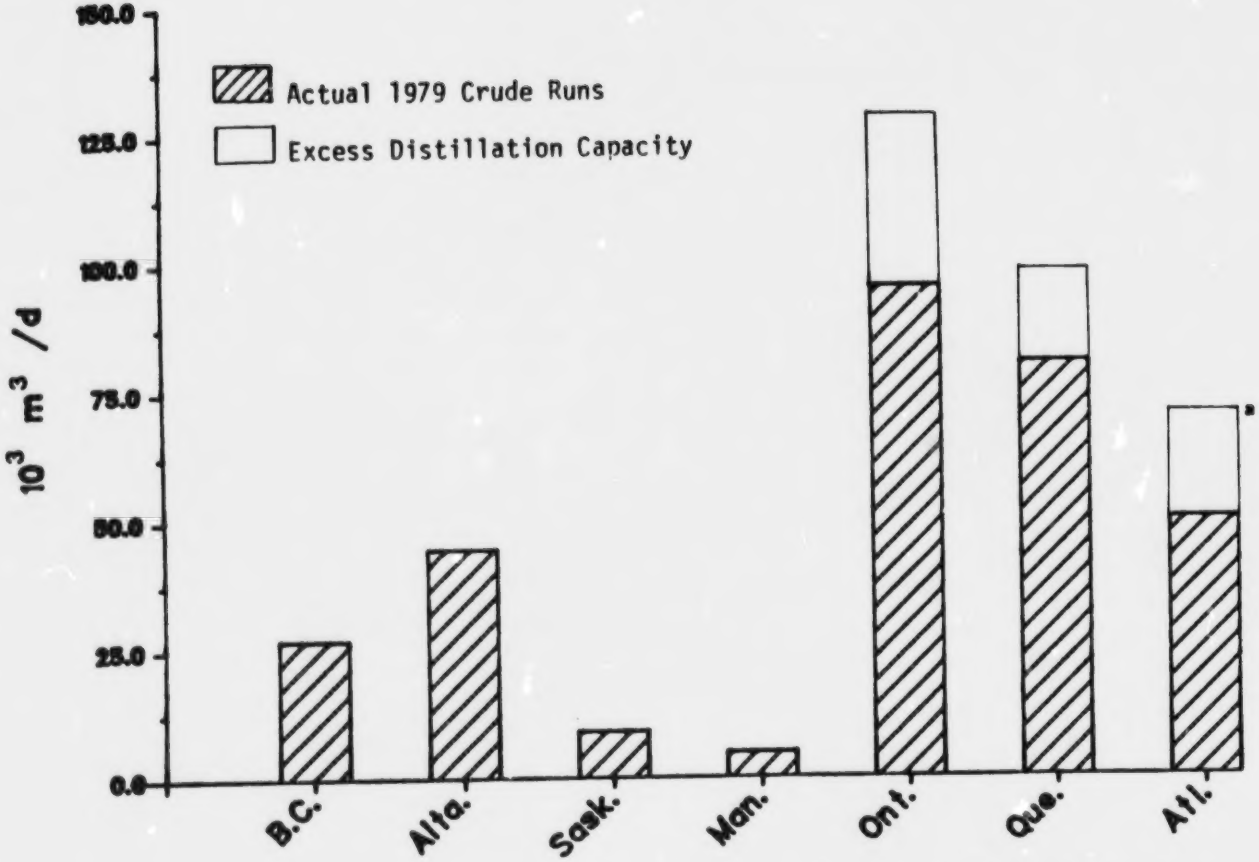


FIGURE 3.5: Canadian Refinery Capacity and Utilization, 1979.
SOURCE: EMR, Petroleum Refineries in Canada, December 1979.

*excludes capacity of mothballed Come-by-Chance refinery.

representative range would best suit the objectives. These three scenarios are illustrated in Figure 3.6.

The base case assumes only marginal growth in total oil demand between 1980 and 2000. The high case corresponds to the 1978 NEB base case, which may be an overly pessimistic estimate. The low case corresponds in a general sense to projections in the recently released National Energy Program except that the time frame has been significantly extended. This forecast may prove to be overly optimistic.

These three crude oil demand cases are shown on a disaggregated regional basis in Table 3.7. The low case regional forecast is characterized by only slight demand growth in western Canada. This is strongly offset, however, by sharp demand reductions anticipated in Ontario, Quebec and the Atlantic provinces.

The base case regional forecast shows growth in every western region, most notably British Columbia and Alberta. In the east, the Ontario and Quebec markets are assumed to decline steadily throughout the forecast period, and the Atlantic region shows only very modest demand growth in response to offshore oil and gas development.

The high case regional forecast is characterized by very strong demand growth in western Canada. In Ontario and the Atlantic region, demand is assumed to expand more rapidly than in the base case but more slowly than in western Canada. Quebec consumption is assumed to remain relatively flat, though at a higher level than in the base case.

Figure 3.7 illustrates regional refining capacity in Canada. Particularly in western Canada, regional refinery capacity will not be sufficient to meet regional demands. This shortage will be met by refined petroleum products obtained through transfers from another region. For the purposes of this paper, it will be assumed that the bulk of incremental western Canadian demand will be met by increases in Alberta refining capacity. Except for this Alberta growth and a moderate capacity increase in British Columbia, refining capacity in all other regions will be assumed constant.

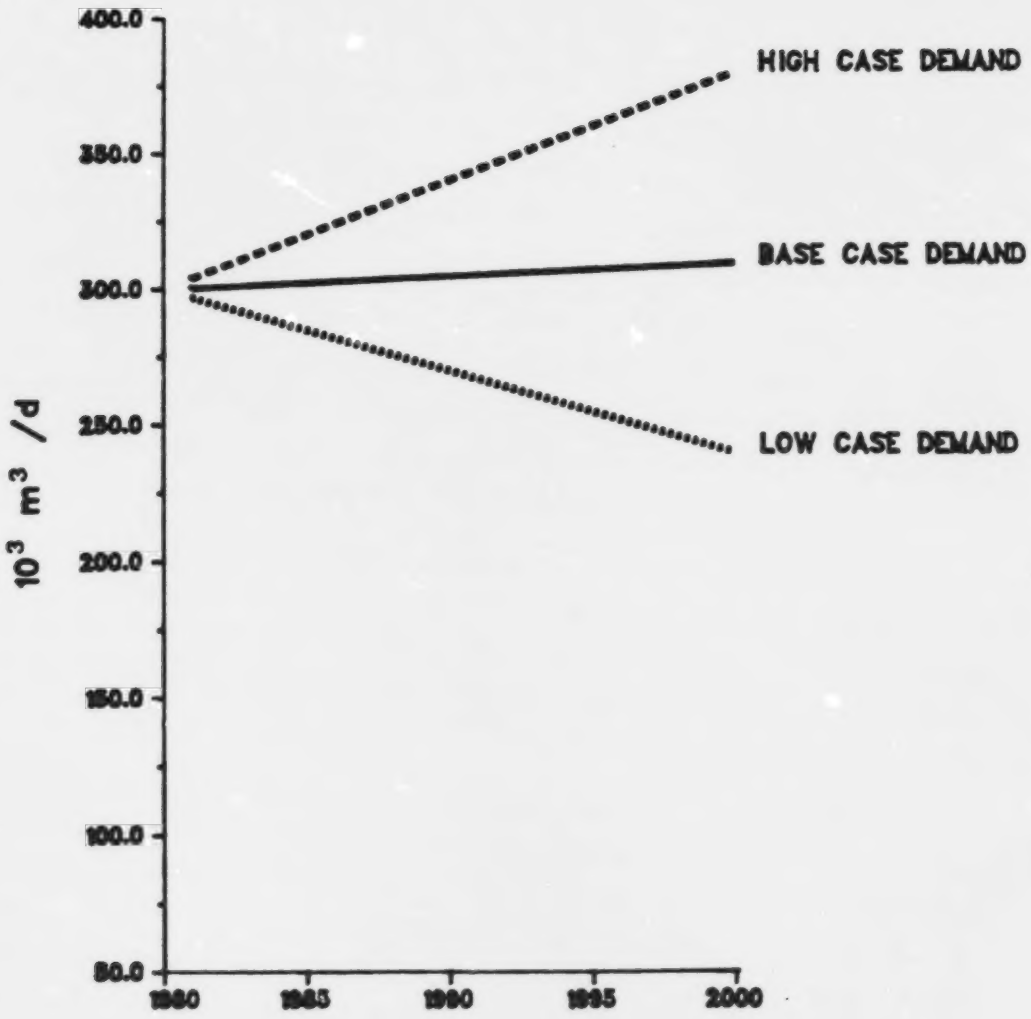


FIGURE 3.6: Crude Oil Demand Scenarios.

TABLE 3.7

REGIONAL CRUDE OIL DEMAND FORECAST[a]
(10^3 m^3/d)

1981

	B.C.	N.W.T.	Alta.	Sask.	Man.	Ont.	Que.	Atl.	Total
Low	30.0	2.1	29.4	11.3	9.5	95.9	80.2	38.6	297.0
Base	30.4	2.1	29.7	11.4	9.6	97.1	81.1	39.1	300.5
High	30.7	2.1	30.1	11.6	9.7	98.2	82.1	39.5	304.0

1985

	B.C.	N.W.T.	Alta.	Sask.	Man.	Ont.	Que.	Atl.	Total
Low	30.2	2.1	32.7	10.8	9.1	69.8	73.0	37.3	285.0
Base	32.1	2.1	34.8	11.5	9.7	95.3	77.4	39.6	302.5
High	33.9	2.2	36.8	12.2	10.3	100.8	81.9	41.9	320.0

1990

	B.C.	N.W.T.	Alta.	Sask..	Man.	Ont.	Que.	Atl.	Total
Low	30.4	2.1	33.1	10.8	8.9	83.7	65.9	35.1	270.0
Base	33.6	2.4	38.1	12.2	10.1	94.5	74.4	39.7	305.0
High	37.4	2.7	42.5	13.6	11.2	105.4	83.0	44.2	340.0

1995

	B.C.	N.W.T.	Alta.	Sask.	Man.	Ont.	Que.	Atl.	Total
Low	30.8	2.1	33.6	10.7	8.4	77.8	58.7	33.1	255.0
Base	36.9	2.5	40.6	12.9	10.1	93.8	70.7	40.0	307.5
High	43.2	2.9	47.5	15.1	11.9	105.8	82.8	46.8	360.0

2000

	B.C.	N.W.T.	Alta.	Sask.	Man.	Ont.	Que.	Atl.	Total
Low	30.7	2.2	33.2	10.1	7.8	72.0	52.8	31.2	240.0
Base	40.6	2.8	41.9	13.0	10.2	93.0	68.2	40.3	310.0
High	49.8	3.4	51.3	16.0	12.5	114.0	83.6	49.4	360.0

[a]This is crude oil demand by region based on final refined petroleum product demand for each specific region.

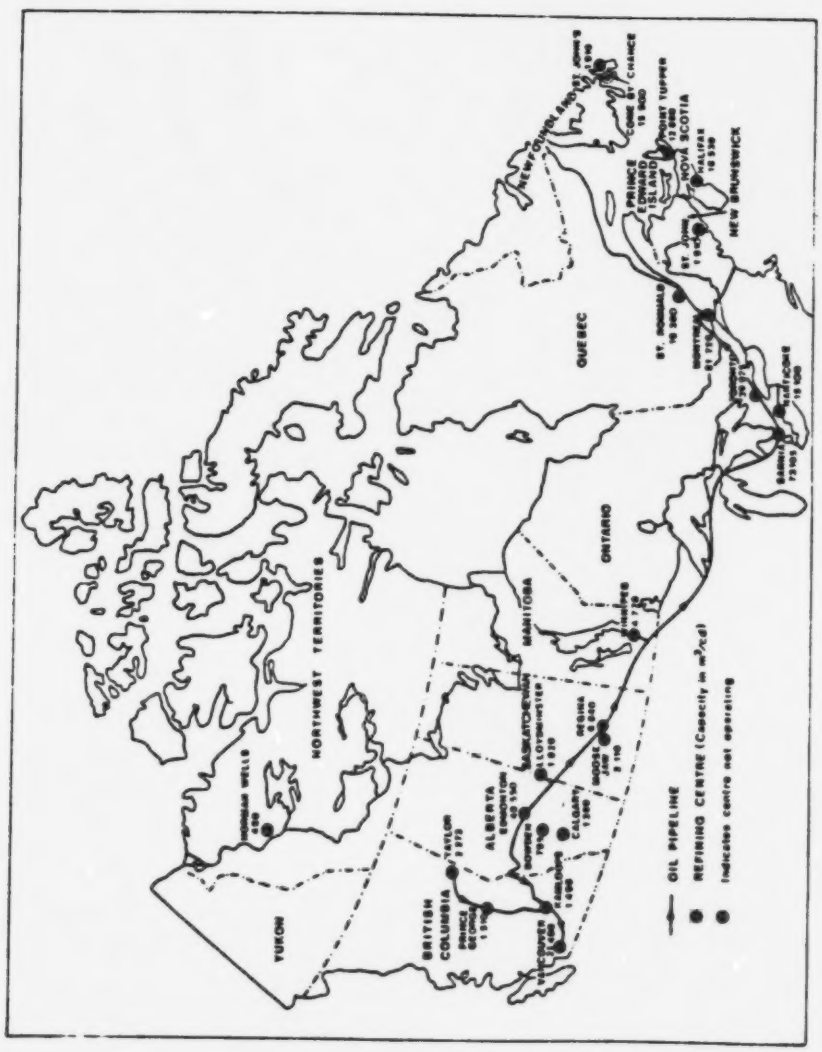


FIGURE 3.7: Refining Centres in Canada.
SOURCE: EMR. Petroleum Refineries in Canada. Ottawa: Supply and Services Canada, 1980.

Table 3.8 summarizes assumed refinery capacity for Alberta and British Columbia. Increases from 1981 capacity for both provinces are expected to be fully on stream by 1985. Additional capacity will be required in Alberta only if high case demand conditions prevail.

TABLE 3.8

REFINERY CAPACITY FORECAST
$10^3 m^3/d$

	Alberta	B.C.
1981	44.5	26.8
1985	71.4	30.0
1990	71.4	30.0
1995	71.4	30.0
2000	71.4	30.0

Our future research program relating to an impact assessment of changing crude oil sources will require an oil demand forecast depicting crude oil refined (as opposed to consumed) by region. In developing such a forecast the following assumptions were used:

1. No major interregional product flows will occur between Ontario and Manitoba.

2. Manitoba and Saskatchewan demand in excess of refinery capacity will be met by Alberta origin refined petroleum products, mostly via InterProvincial's refined products line.

3. British Columbia demand in excess of provincial refining capacity will be met by refined petroleum product transfers from Alberta, or partially refined light oil streams from Alberta refineries via Trans Mountain Pipeline.

4. Ontario, Quebec and the Atlantic provinces will have sufficient refining capacity to meet their own refined petroleum products demand.

Based on these assumptions, and given refining capacity constraints, low, base and high case projections of crude oil demand, disaggregated to a regional level, were developed as illustrated in Table 3.9. On this basis, Saskatchewan and Manitoba crude runs will be constrained by refinery capacity in every forecast year. A marginal increment will occur in British Columbia, and Alberta capacity will be large enough to meet western demands. Eastern capacity will be sufficient to fully meet demand. This forecast of regional refinery demand is combined with supply estimates to develop supply/demand matrices in Chapter 4.

Appendix B provides underlying petroleum product demand estimates by region and specific product, consistent with the aggregate crude oil demand scenarios. The low, base, and high case forecasts will be used in future research. The general details related to the development of these specific product forecasts are summarized in the preamble to Appendix B.[2]

TABLE 3.9

REFINERY DEMAND FORECAST[a]
($10^3 m^3/d$)

1981

	B.C.	N.W.T.	Alta.	Sask.	Man.	Ont.	Que.	Atl.	Total
Low	26.8	0.4	41.3	9.0	4.8	95.9	80.2	38.6	297.0
Base	26.8	0.4	42.2	9.0	4.8	97.1	81.1	39.1	300.5
High	26.8	0.4	43.2	9.0	4.8	98.2	82.1	39.5	304.0

1985

	B.C.	N.W.T.	Alta.	Sask.	Man.	Ont.	Que.	Atl.	Total
Low	30.0	0.4	40.7	9.0	4.8	89.8	73.0	37.3	285.0
Base	30.0	0.4	46.0	9.0	4.8	95.3	77.4	39.6	302.5
High	30.0	0.4	51.2	9.0	4.8	100.8	81.9	41.9	320.0

1990

	B.C.	N.W.T.	Alta.	Sask.	Man.	Ont.	Que.	Atl.	Total
Low	30.0	0.4	41.1	9.0	4.8	83.7	65.9	35.1	270.0
Base	30.0	0.4	52.2	9.0	4.8	94.5	74.4	39.7	305.0
High	30.0	0.4	63.2	9.0	4.8	105.4	83.0	44.2	340.0

1995

	B.C.	N.W.T.	Alta.	Sask.	Man.	Ont.	Que.	Atl.	Total
Low	30.0	0.4	41.2	9.0	4.8	77.8	58.7	33.1	255.0
Base	30.0	0.4	58.6	9.0	4.8	93.8	70.7	40.0	307.5
High	30.0	0.4	76.4	9.0	4.8	109.8	82.8	46.8	360.0

2000

	B.C.	N.W.T.	Alta.	Sask.	Man.	Ont.	Que.	Atl.	Total
Low	30.0	0.4	39.8	9.0	4.8	72.0	52.8	31.2	240.0
Base	30.0	0.4	64.3	9.0	4.8	93.0	66.2	40.3	310.0
High	30.0	0.4	88.8	9.0	4.8	114.0	83.6	49.4	380.0

[a]This represents demand for crude oil to be refined in a specific region. The refined petroleum product yield would not necessarily be consumed in that region.

Footnotes

[1]This product slate is based on classifications reported by Statistics Canada. Substitution may occur between products due to overlap in the technical definition of products. Statistics Canada data, however, show product production based on anticipated end use and not technically defined limits. Therefore, potential ambiguities are minimized.

[2]Refined petroleum product demands as a percentage of the total barrel do not vary between low, base, and high case demand forecasts. The base case already embodies demand trends that are anticipated. It is felt that high or low RPP demand will be characterized by absolute variations above or below the base case and that the relative demands for certain products will not change.

Chapter 4

SUPPLY/DEMAND INTEGRATION

Crude oil supply forecasts were developed in Chapter 2 for three representative supply cases. Similarly, refined petroleum product demand forecasts and total crude oil demand forecasts were developed in Chapter 3. The purpose of this chapter is to bring these supply and demand forecasts together to illustrate their combined effect on Canada's oil balance.

The impact of various supply/demand scenarios is evaluated from two perspectives. At the aggregate level, different scenarios will be examined to indicate Canada's overall dependence on foreign crude. At the specific level, precise sources and regional uses of crude oil will be examined, forming a detailed data base for future research. The chapter provides a discussion of the integration of supply and demand at these two levels of detail and provides a starting point for careful assessment of the impact of changes in the quality and availability of domestic and foreign crudes.

4.1 Aggregate Analysis

Foreign crude oil supplies rate poorly relative to the supply criteria outlined in Chapter 2 of this paper.[1] Therefore, the degree to which Canada is reliant upon these foreign supplies is a critical question. The level of Canada's dependence on foreign crude has been classified into three broad categories as summarized in Table 4.1. Self-reliance and self-sufficiency represent good and best cases respectively, and relate directly to past and present policy goals of the federal government.[2] Foreign dependence is the worst case and represents failure to stimulate supply and/or curb demand.

TABLE 4.1

CLASSIFICATIONS OF FOREIGN SUPPLY DEPENDENCE

Classification	Abbreviation	Description
Foreign Dependence	FD	• imports greater than 1/3 of total domestic crude oil requirements • characterized by high risk, volatile price, potentially severe downside consequences related to supply disruption
Self-reliance	SR	• imports less than 1/3 of total domestic crude oil requirements • characterized by volatile price and reduced risk related to supply disruption vis-a-vis the FD case.
Self-sufficiency	SS	• net imports zero • characterized by minimum exposure to world market risks

For each forecast year, the three cases of supply and three cases of demand can be combined in a matrix as illustrated in Table 4.2. For each of the nine matrix elements, the net crude oil surplus or deficiency may be calculated.[3] This calculated oil surplus or deficiency for each supply/demand combination can then be classified as foreign dependence, self-reliance, or self-sufficiency.

TABLE 4.2

PRO FORMA SUPPLY/DEMAND MATRIX

		Demand		
		Low	Base	High
S U P P L Y	Low			Pessimistic Scenario
	Base		Median Scenario	
	High	Optimistic Scenario		

A computer model was developed to perform these and other manipulations on the aggregate supply/demand data. Preliminary results are detailed in Table 4.3.

In 1981, self-reliance is indicated no matter what supply/demand combination occurs. In 1985, low case supply will result in foreign dependence, and self-sufficiency will not be possible. In 1990, self-reliance is indicated for almost every supply and demand combination. Again, foreign dependence will occur for the more pessimistic supply/demand combinations. By 1995, optimistic scenarios show self-sufficiency as a possibility. As before, foreign dependence is indicated for the more pessimistic scenarios. In the year 2000, achieving high case supply will guarantee self-sufficiency, with foreign dependence still a possibility for the pessimistic scenarios.

TABLE 4.3

CRUDE OIL SUPPLY/DEMAND FORECAST MATRICES BY YEAR
$10^3 m^3/d$

1981

SUPPLY \ DEMAND	low 297.0	base 300.5	high 304.0
low 221.7	-75.3 sr	-78.8 sr	-82.3 sr
base 246.1	-50.9 sr	-54.4 sr	-57.9 sr
high 270.5	-26.5 sr	-30.0 sr	-33.5 sr

1985

SUPPLY \ DEMAND	low 285.0	base 302.5	high 320.0
low 189.6	-95.4 fd	-112.9 fd	-130.4 fd
base 211.0	-74.0 sr	-91.5 sr	-109.0 fd
high 232.4	-52.6 sr	-70.1 sr	-87.6 sr

1990

SUPPLY \ DEMAND	low 270.0	base 305.0	high 340.0
low 200.5	-69.5 sr	-104.5 fd	-139.5 fd
base 222.6	-47.4 sr	-82.4 sr	-117.4 fd
high 244.7	-25.3 sr	-60.3 sr	-95.3 sr

1995

SUPPLY \ DEMAND	low 255.0	base 307.5	high 360.0
low 180.3	-74.7 sr	-127.2 fd	-179.7 fd
base 234.9	-20.1 sr	-72.6 sr	-125.1 fd
high 349.7	94.7 ss	42.2 ss	-10.3 sr

2000

SUPPLY \ DEMAND	low 240.0	base 310.0	high 380.0
low 167.9	-72.1 sr	-142.1 fd	-212.1 fd
base 284.4	44.4 ss	-25.6 sr	-95.6 sr
high 381.3	141.3 ss	71.3 ss	1.3 ss

Code: FD: foreign dependence
SR: self-reliance
SS: self-sufficiency

4.1.1 Representative Scenarios

As stated previously, low case, base case, and high case forecasts have been developed for both supply and demand. Therefore, there are nine possible supply/demand combinations for each year. In order to simplify the analysis somewhat, but still illustrate the complete range of crude oil supply/demand combinations, it was determined that two extreme scenarios and a median scenario would be defined. The pessimistic scenario represents a 'worst case' outlook characterized by low case supply and high case demand in each forecast year. The median scenario represents a 'middle road' outlook with base case supply and base case demand in each forecast year. The optimistic scenario represents a 'best case' outlook characterized by high case supply and low case demand in each forecast year. These representative scenarios and their relationship to the nine possible scenarios are shown in Table 4.2. Precise supply and demand values are summarized in Table 4.4.

Pessimistic, median, and optimistic forecast scenarios of the aggregate Canadian crude oil supply/demand balance are illustrated in Figure 4.1. The pessimistic outlook depicts strong demand growth throughout the forecast period coupled with a steady deterioration in domestic supply capability.[4] The result is a large increase in net crude oil imports to the year 2000.

The median scenario shows moderate demand growth during the forecast period, with supply falling to a minimum in 1985 and steadily increasing thereafter.[5] Self-sufficiency would <u>not</u> be attained by the year 2000, but the level of imports would be reduced to fairly modest levels.

The optimistic scenario illustrates a substantial demand reduction coupled with large supply increases.[6] Self-sufficiency would be reached by the early 1990s, and a significant exportable surplus would be available thereafter. Of course, dependence on oil imports would be nil.

TABLE 4.4

AGGREGATE CRUDE OIL SUPPLY/DEMAND SCENARIOS
$10^3 m^3/d$

Scenario	1981	1985	1990	1995	2000
Pessimistic					
Supply	221.7	189.6	200.5	180.3	167.9
Demand	304.0	320.0	340.0	360.0	380.0
Surplus	- 82.3	-130.4	-139.5	-179.7	-212.1
Median					
Supply	246.1	211.0	222.6	234.9	285.4
Demand	300.5	302.5	305.0	307.5	310.0
Surplus	- 54.4	- 91.5	- 82.4	- 72.6	- 24.6
Optimistic					
Supply	270.5	232.4	244.7	349.7	381.3
Demand	297.0	285.0	270.0	255.0	240.0
Surplus	- 26.5	- 52.6	- 25.3	94.7	141.3

SOURCE: Table 4.3.

NOTE: These cases are related to the supply/demand matrix developed in Table 4.2. They represent only three of the nine possible matrix elements.

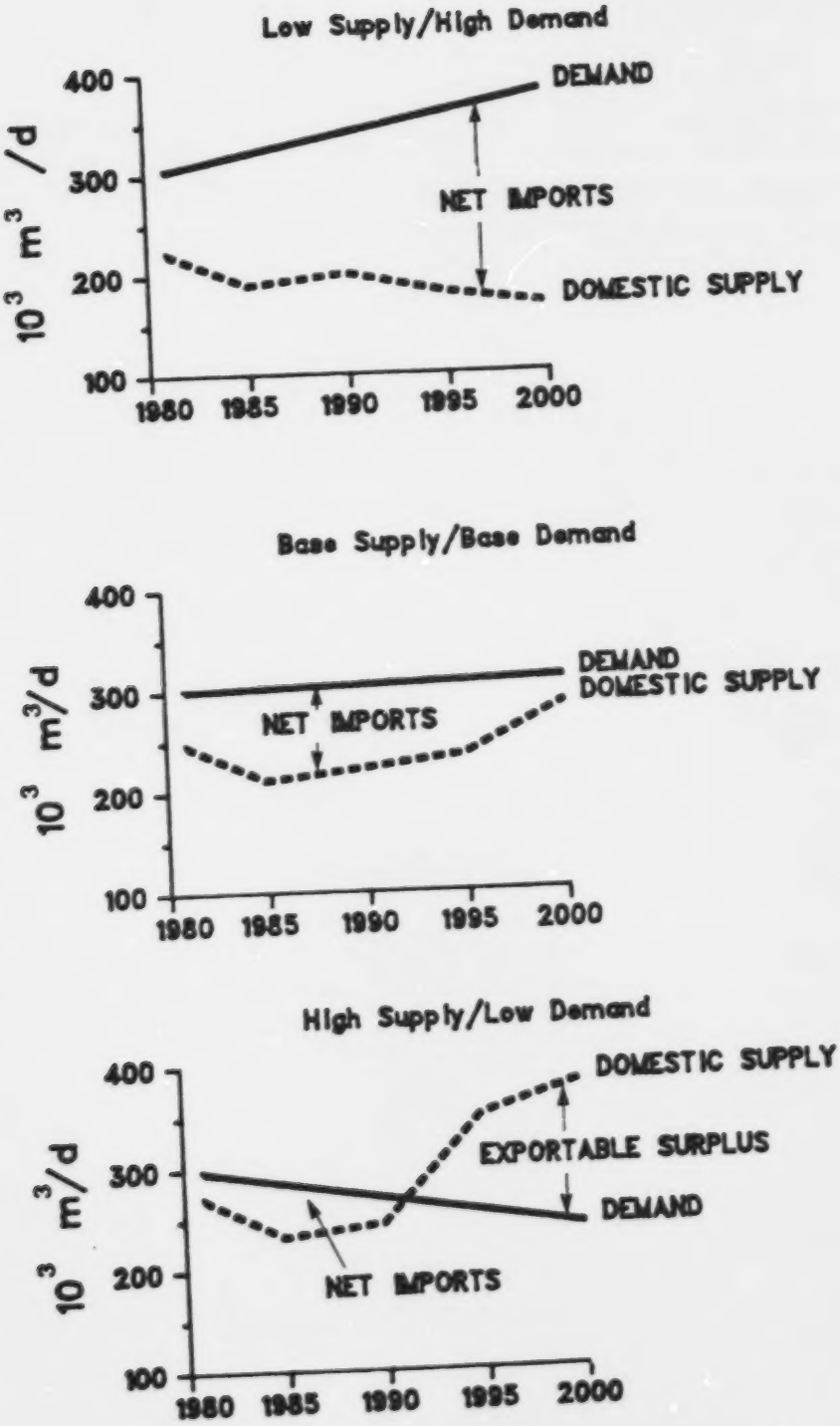


FIGURE 4.1: Crude Oil Supply/Demand Scenarios.

4.1.2 Computer Analysis

Thus far in this chapter, the likelihood of each specific supply or demand case occurring has not been addressed. Until now the pessimistic, median, and optimistic scenarios have reflected the extremes in supply and demand cases. They represent the maximum range in which a most likely scenario will probably fall.

It is important to note, however, that the determination of a most likely scenario is somewhat more complex. An individual may not perceive one specific supply case and one specific demand case to be the only possible scenario. Rather, one case may be more likely than others, but not totally certain. Therefore, a relative weight would have to be assigned the three cases, based on perceived likelihood of occurrence.

To facilitate this analysis for each forecast year, a computer model was designed to calculate:

- the overall probabilistic expected value of crude oil surplus or deficiency
- the probability of foreign dependence
- the probability of self-reliance
- the probability of self-sufficiency.

The input required for these calculations consists of probability estimates related to the occurrence of low, base, and high case supply as well as probability estimates related to the occurrence of low, base, and high case demand.

The low, base, and high case supply forecasts are mutually exclusive events and, for the purposes of workability, will be considered to represent the entire event set. The total of the probabilities assigned to each case must therefore equal 1.0. The same applies to low, base, and high case demand forecasts.

The probability of a specific supply case occurring with a specific demand case is known as a joint probability. This value is computed by multiplying the assigned probability of the supply case by

the assigned probability of the demand case and is represented as follows:

$$P(S \text{ and } D) = P(S) \cdot P(D)$$

The probability for each supply/demand matrix element may be calculated using this formula. By definition, since the nine matrix elements represent the entire event set, the sum of all matrix element probabilities must equal 1.0.

The overall expected value of crude oil surplus or deficiency for a certain forecast year is calculated by:

$$EV = \sum_{i=1}^{9} (JP \cdot SD_i)$$

where EV = expected value surplus/<deficiency> for the forecast year

JP = joint probability of specific supply/demand matrix element

SD = volumetric surplus or deficiency of oil for specific supply/demand matrix element

i = matrix element

The overall expected crude oil surplus or deficiency for a given forecast year is the sum of the joint probability multiplied by the value of each matrix element.

The probabilities of foreign dependence, self-reliance, and self-sufficiency are calculated by:

$$P(FD) = \sum (JPFD)$$
$$P(SR) = \sum (JPSR)$$
$$P(SS) = \sum (JPSS)$$

where JPFD = joint probability of matrix element indicating foreign dependence

JPSR = joint probability of matrix element indicating self-reliance

JPSS = joint probability of matrix element indicating self-sufficiency.

For example, the probability of self-sufficiency in a given year is the sum of the joint probabilities related to every matrix element for which self-sufficiency is indicated.[7]

4.1.3 Model Results for Representative Scenarios

Arbitrary supply case and demand case probability estimates were selected to reflect scenarios showing pessimistic, median and optimistic crude oil supply/demand outlooks. The methodology and results of the subsequent computer analysis are discussed in Appendix section C.1.

In very general terms, the pessimistic scenario indicated a large and steady oil deficiency throughout the forecast period. The probability of foreign dependence would be high. The median scenario showed a relatively moderate deficiency by the year 2000. The probability of self-reliance would be high. The optimistic scenario indicated a growing oil surplus by 1995. The probability of self-sufficiency in later forecast years would be high.

Notice that the expected values of supply surplus or deficiency discussed here relate fairly closely to the scenarios depicted in Figure 4.1. By definition, however, they account for probabilities of other supply and demand cases as well.

4.1.4 Model Results for Most Likely Scenario

Until this point in the chapter, it has not been appropriate to describe the rationale for utilizing this probabilistic technique of evaluating potential crude oil supply and demand. In short, the technique provides a method through which the inherent uncertainties in oil supply and demand can be dealt with. Even the most technical and quantitative forecast of crude supply and demand has a significant margin for error. There must be some mechanism by which the forecaster can incorporate valuable perception and judgement in the overall analysis. This technique provides such a vehicle.

The preceding section describes model results for a median and two extreme scenarios of crude oil supply and demand. While quantifying these best and worst case scenarios is a valuable exercise, the real usefulness of the technique is demonstrated when real perceptions of crude oil supply and demand are used. The following analysis, therefore, was based on general political, economic and technical considerations that will have an impact on crude oil supply and demand.

The crude oil supply potential in Canada hinges to a very large degree on government pricing policy. Current federal pricing proposals have been described as too low to fully exploit this supply potential. There is a real urgency to develop these domestic oil supplies. It is critical that governments recognize this urgency and develop pricing policies and incentives (whatever they may be) that will stimulate a supply response.

One critical assumption made in this analysis is that governments will <u>eventually</u> reach a pricing agreement that will ensure steady development of all oil sources. This means that oil sands and frontier development will proceed, and enhanced recovery projects will be economic subject to technical limitations.

Given this assumption, probability estimates were assigned to low, base, and high case supply forecasts in accordance to their perceived likelihood of occurrence.[8] As described below, the outlook

is fairly optimistic. It must be emphasized, however, that if more attractive oil pricing policies are not put in place, this outlook should be significantly more pessimistic.

- Low Case Supply Probability = 0.10

  Given pricing assumptions, the risk of severely limited oil sands development appears slim. In addition, frontier potential is probably higher than assumed in the low case supply forecast.

- Base Case Supply Probability = 0.60

  Given pricing assumptions, steady development of oil sands is likely. Frontier production may not be at full potential before 2000.

- High Case Supply Probability = 0.30

  Accelerated development of oil sands may be difficult. On the upside, however, frontier production could be at full potential by 1995.

The assumed probabilities related to low, base, and high case demand forecasts reflect the general perception that oil demand will moderate. As mentioned before, future government policies will be crucial to the attainment of these goals. Motivation to conserve oil products or substitute other energy forms for oil products will occur both through government programs and the price mechanism itself. Again, it is critical to note that if new pricing policies are not put in place, these probability estimates should be considerably more pessimistic.

- Low Case Demand Probability = 0.40

  Substitution and conservation (including improved automobile fuel efficiency) could significantly reduce demand.

- Base Case Demand Probability = 0.40

  General economic growth may dampen the potential impact of substitution and conservation. For lack of a clearer outlook, low case and base case will be considered equally probable.[9]

- High Case Demand Probability = 0.20

  Given pricing assumptions, the likelihood of sustained demand growth is unlikely for reasons shown above.

Taken together, these crude oil supply and demand outlooks fall somewhere between the median and optimistic scenarios described earlier. This reflects the general perception that Canada's oil supply potential is high given the proper economic climate, and that some form of demand side response will be necessary if self-sufficiency is to be obtained by the end of the century. The computer model results are summarized in Table 4.5, and graphically illustrated in Figures 4.2 and 4.3.

TABLE 4.5

PROBABILITY SUMMARY OF CRUDE OIL SUPPLY/DEMAND FORECAST
MOST LIKELY SCENARIO

	1981	1985	1990	1995	2000
Expected value of Supply Surplus/<deficiency> ($10^3 m^3/d$)	<48.8>	<83.7>	<71.0>	<33.1>	5.8
Probability of:					
Foreign Dependence	ø	0.22	0.18	0.18	0.06
Self-Reliance	1.00	0.78	0.82	0.58	0.40
Self-Sufficiency	ø	ø	ø	0.24	0.54
	1.00	1.00	1.00	1.00	1.00

The analysis indicates that oil self-sufficiency by 1990 is not likely. The expected value of crude oil imports in that year will be 71 000 m^3/d, or 24 percent of total expected oil demand. In the year 2000, Canada will be at least self-reliant, with the probability of self-sufficiency being better than one-half. There will be an expected crude surplus of 5 800 m^3/d in that year.

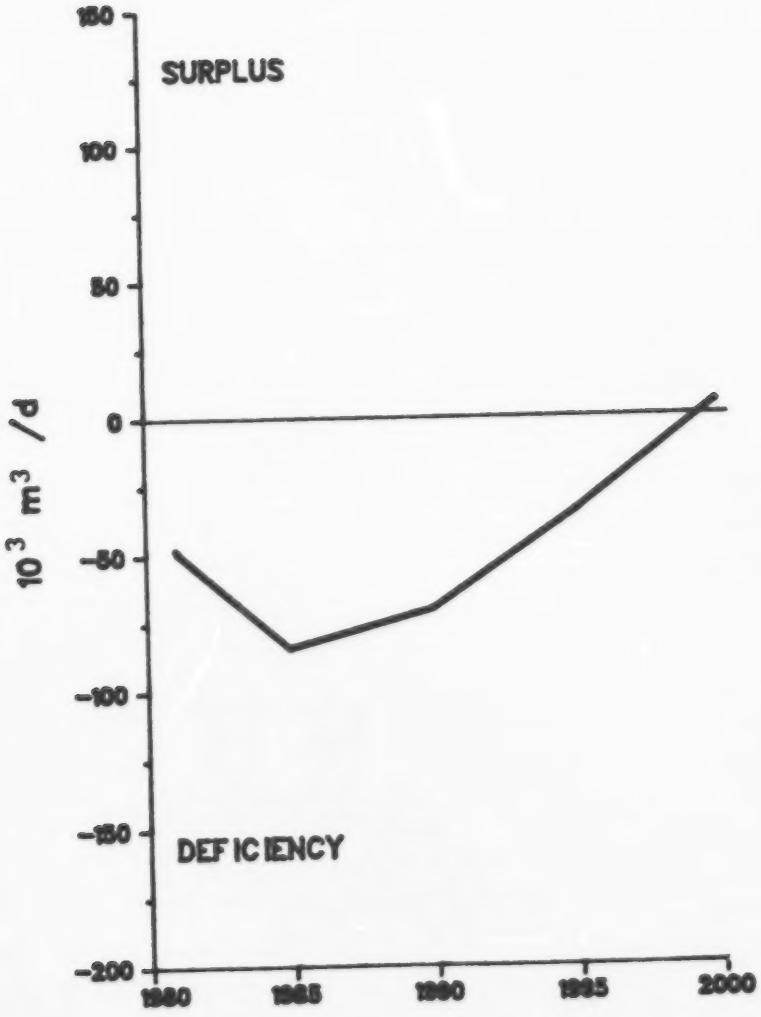


Figure 4.2: **Expected Value of Crude Oil Surplus or Deficiency.**
SOURCE: Table 4.5.

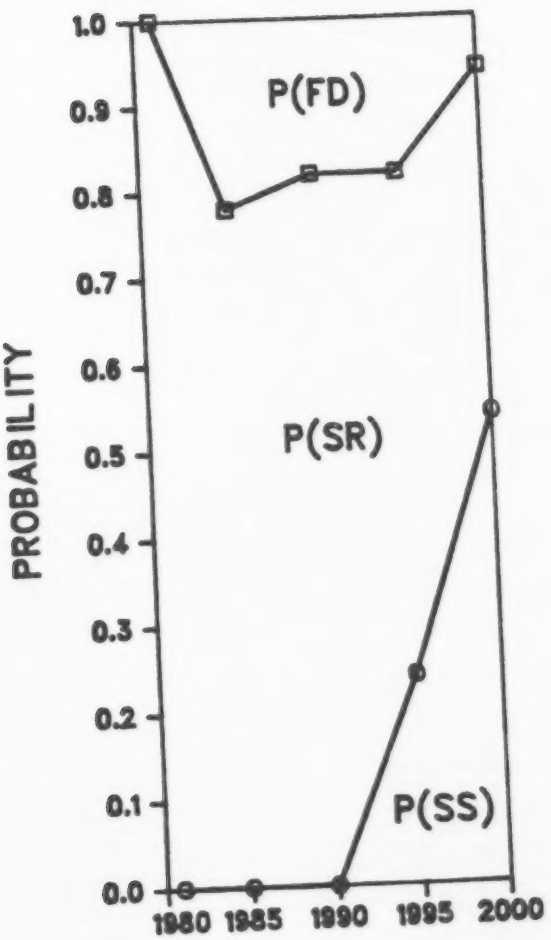


FIGURE 4.3: Probabilities of Foreign Oil Dependence.
SOURCE: Table 4.5

4.2 Source-Use Specific Analysis

The preceding section demonstrates likely paths that crude oil supply and demand could take (at the aggregate level) and is important due to the risks related to foreign oil dependence. At the source-use specific level, however, this information is not as important as determining which specific crude types (both foreign and domestic) will be run in each particular refining region.

The detailed integration of supply and demand in this section will form a substantial part of the data base utilized in subsequent research. Combined with the preceding aggregate analysis, a clearer view of regional crude supply and demand has been developed.

The flow of specific types of crude oil to particular geographic refining regions is a function of several broad factors. These factors are summarized below.

- Pipeline Infrastructure and Operation

  The movement of crude oil is limited by the physical pipeline network in place. Direction of flow, throughput capacity, and detailed operating characteristics, place physical constraints on the movement of certain crude types to certain locations. For example, crude from the Bow River system cannot easily move to Vancouver refineries, and similarly no pipeline exists to move domestic crude to the Atlantic region.

- Supply Patterns

  Based on technical and economic criteria, refiners have developed preferences for certain crude oil diets. To a large degree, these historic supply patterns have been maintained over the years, and will still form the foundation for crude supply patterns in the future. For example, technical constraints limit the ability of eastern refiners to run heavy, high sulphur Lloydminster type crude. Lighter sweet or sour crude blends are preferred.

- Political Choice

  Recent events have illustrated the desire of Alberta to exert more control over the ultimate use of its crude oil. Effective April 1, 1980, the majority of oil production in the province has been transported and sold by the Alberta Petroleum Marketing Commission to refiners of its choice. Preferred feedstocks will be retained in Alberta. Production levels are also under government control.

- Foreign Avails

  Exporting nations are moving towards a rationalization of their crude oil marketing policies. The international supply systems of multinational oil companies are being short circuited by way of government to government agreements. Political and commercial factors are often integral components of such deals. The result has been a shifting of supply patterns, and a loss of flexibility by multinational supply operations.[10] For example, the import of heavy Mexican crude by Petro-Canada is a government to government deal and reduces the flexibility of eastern refiners to run higher quality crudes.

These four factors figure predominantly in the development of an integrated supply/demand forecast at the source-use specific level.

For future research, the major question is what specific crude types will be run in each refining region? Table 4.6 summarizes the important assumptions used in forecasting these source-use specific flows of crude oil, based on the four major factors described above.

The methodology adopted in the determination of which specific crude types would be run in specific refining regions involved a two-step process. First, a preliminary source-use allocation was made using a linear programming algorithm. Second, this preliminary allocation was fine tuned to reflect specific supply/demand relationships. The initial allocation of crude oil to refining regions is well suited to a linear programming formulation. Specifically, a computer-based

TABLE 4.6

ASSUMPTIONS USED IN DETAILED SUPPLY/DEMAND MATRICES

Pipeline Infrastructure	Supply Patterns	Political Choice	Foreign Availability
• Sweet and Sour mix blends will be the only light crude streams available to eastern refiners via IPL. • TMPL will continue batch operations, moving specific crude types to Vancouver refiners. • The gas pipeline extension to the Atlantic will occur. • Toronto-Montreal oil line could be reversed to supply Ontario with foreign crude.	• Only heavy crudes and sour mix blend will be available to Montreal refiners via IPL. • Frontier crude will be consumed in the Atlantic region, and possibly Quebec. • B.C. refiners will get feedstock type priority over eastern refiners.	• Preferred crude streams will be retained in Alberta. • No $C5^+$ will be available to refiners outside Alberta. • Import subsidies will not cause refiners to favour certain crude types over others.	• The availability of light sweet crude will decrease considerably. • Venezuelan crude, or crudes of equivalent quality, will form the majority of imports. • Middle East crudes will have decreasing presence in imports.

transportation algorithm was used to make this preliminary allocation.[11]

The cost coefficients utilized are shown in Table 4.7. All infeasibilities (real or induced) were assigned an infinite cost. Other cost coefficients were determined as follows:

- Light, sweet crudes[12] produced in Alberta will be used to the extent possible in Alberta. The next most likely destination will be British Columbia, followed by Saskatchewan, Manitoba and Ontario equally likely, and finally with Quebec having relatively poor access to light, sweet crude. Therefore, cost coefficients are:

  1 Alberta
  2 British Columbia
  3 Saskatchewan, Manitoba, Ontario
  4 Quebec

- Heavy, sour crude will be retained in western Canada to meet asphalt demand only, leaving the export market, Ontario, and Quebec as the most likely destinations. Therefore, cost coefficients are:

  1 United States
  3 Quebec
  4 Alberta, Saskatchewan, Manitoba, Ontario

- Pentanes plus will be consumed almost entirely in Alberta as petrochemical development grows. Therefore, cost coefficients are:

  1 Alberta
  4 British Columbia, Saskatchewan, Manitoba, Ontario, Quebec

- Synthetic oil was treated the same as light, sweet crude described above. Fine-tuning of synthetic oil allocations was required, and is described later. Cost coefficients are:

  1 Alberta
  2 British Columbia
  3 Saskatchewan, Manitoba, Ontario
  4 Quebec

- Foreign oil was considered very undesirable, therefore a high cost coefficient was assigned:

  5 Quebec, Atlantic

TABLE 4.7

TRANSPORTATION ALGORITHM COST COEFFICIENTS[a]

		B.C.	N.W.T.	Alta.	Sask.	Man.	Ont.	Que.	Atlan.	U.S.
B.C.	Blueberry Taylor	1	-[b]	-	-	-	-	-	-	-
	Beatton River	1	-	-	-	-	-	-	-	-
	B. Lake	1	-	-	-	-	-	-	-	-
	Ext. & Discoveries	1	-	-	-	-	-	-	-	-
	Tertiary	1	-	-	-	-	-	-	-	-
	Pentanes Plus	1	-	-	-	-	-	-	-	-
N.W.T.	Norman Wells	-	1	-	-	-	-	-	-	-
Alta.	Bow River L & M	-	-	-	1	1	1	4	-	1
	Bow River H	-	-	-	4	4	4	3	-	1
	BP heavy	-	-	-	4	4	4	3	-	1
	Cremona	2	-	1	3	3	3	4	-	-
	Federated	2	-	1	3	3	3	4	-	-
	Gibson	-	-	-	2	2	2	1	-	-
	Gulf Alta	3	-	4	2	2	2	1	-	1
	Husky & Manito H	-	-	1	-	-	-	-	-	-
	Imp. Ellerslie	2	-	1	3	3	3	4	-	-
	Imp. Excelsior	3	-	4	2	2	2	1	-	-
	Imp. Leduc	2	-	1	3	3	3	4	-	-
	Imp. Redwater	2	-	1	3	3	3	4	-	1
	Murphy	-	-	-	2	2	2	1	-	-
	Norcen	2	-	1	3	3	3	4	-	-
	Peace River	2	-	1	3	3	3	4	-	-
	Pembina	2	-	1	3	3	3	4	-	-
	Rainbow	2	-	1	3	3	3	4	-	-
	Rangeland	-	-	-	-	-	-	-	-	1
	Texaco	2	-	1	3	3	3	4	-	-
	Trans Prairie: BL	1	-	-	-	-	-	-	-	-
	Twining	2	-	1	3	3	3	4	-	-
	Valley	-	-	1	-	-	-	-	-	-
	Synthetic	2	-	1	3	3	3	4	-	-
	Ext. & Discoveries	2	-	1	3	3	3	4	-	-
	Tertiary	3	-	4	2	2	2	1	-	-
	Pentanes Plus	4	-	1	4	4	4	4	-	-
Sask.	Bow River H	-	-	-	4	4	4	3	-	1
	Husky & Manito H	-	-	-	4	4	4	3	-	1
	South Sask. H	-	-	-	4	4	4	3	-	1
	Westspur H	-	-	-	-	4	4	3	-	1
	Westspur Batch Light	-	-	-	-	4	4	1	-	1
	SE Sask. light	-	-	-	-	4	4	1	-	1
	Synthetic	-	-	-	1	1	1	4	-	-
	Ext. & Discoveries	-	-	-	1	1	1	4	-	-
	Tertiary	-	-	-	4	4	4	1	-	-
	Pentanes Plus	-	-	-	1	1	1	4	-	-
Man.	Trans Prairie	-	-	-	-	1	1	4	-	-
Ont.	Light	-	-	-	-	-	1	4	-	-
Frontier		-	-	-	-	-	-	2	1	-
Foreign		-	-	-	-	-	-	5	5	-

[a]These coefficients are not costs of shipment, per se, but rather measures of the relative propensity of specific feedstocks to be refined in specific regions.

[b]'-' represents an infinite coefficient value assigned to physical and economic infeasibilities, as well as restrictions necessary to insure realistic allocations.

- Frontier oil was considered most likely to be run in the Atlantic, and then perhaps Quebec. Therefore, cost coefficients are:

  1 Atlantic
  2 Quebec

The transportation algorithm is formulated with the objective function being the total 'cost' of transporting oil from all sources to all destinations. This objective function is minimized subject to the various constraints defined in the cost matrix.

Results of the transportation allocation analysis for base case supply and base case demand are shown in Tables D.2 through D.6. Synthetic oil allocations were adjusted to reflect expected supply/demand relationships. While the algorithm has allocated crude by type to the refining markets east of Alberta, future research will aggregate these crude types as sweet or sour mix blend. Feedstock by specific type will be used for Alberta and British Columbia. Foreign oil imports were adjusted to reflect domestic pipeline capacity constraints into Montreal. This foreign oil will include a larger proportion of Venezuelan crude to reflect the decline in imported oil quality.

4.3 Pricing

The various scenarios described in this paper do not incorporate the assumption of price consistency between supply and demand as found in simultaneously derived econometric forecasts of crude oil supply and refined petroleum product demand. The uncertainties related to government incentives, taxation, and pricing policies make such an assumption tenuous. The 'most likely scenario' described in Section 4.1.4 does, however, reflect a large degree of uniformity in producer netback and refined petroleum product price outlooks.

Footnotes

[1]Foreign crude can be related to the five supply objectives as follows:

- Security - Foreign crude is susceptible to near-term supply disruption.
- Longevity - The supply of foreign crude is getting tighter, particularly as net exporters become net importers (i.e., the U.S.S.R.).
- Quality - Foreign crude oil quality is decreasing, therefore becoming more difficult to refine.
- Transportability - Tanker transport has certain ecological risks, in addition to logistic disadvantages vis-a-vis pipelines. Certain transportation problems may also arise if import requirements to Montreal reach too high a level.
- Economy - The price of foreign crude is high and quite volatile. The cost of subsidizing these expensive feedstocks through the Petroleum Compensation Board is very high.

[2]Canada, Department of Energy, Mines and Resources, An Energy Strategy for Canada: Policies for Self-Reliance (Ottawa: Supply and Services), 1976. Self Reliance was defined as limiting oil imports to one-third of total domestic requirements. Self-sufficiency, defined as a net import dependence of zero, is the new goal of the federal government. See: Canada, Department of Energy, Mines and Resources, The National Energy Program (Ottawa: Supply and Services), 1980.

[3]Subtract the demand value on the horizontal axis from the supply value on the vertical axis. The difference is the net surplus or deficiency for that particular supply/demand combination.

[4]The pessimistic supply/demand scenario generally corresponds to a maintenance of very low domestic oil prices. Demand would grow, both due to a lack of price induced conservation and no incentive for consumers to switch to alternate sources of energy. Supply would decrease steadily, reflecting the decrease in conventional light and medium production and a lack of financial incentives for synthetic and frontier development.

[5]The median supply/demand scenario generally corresponds to a moderate oil price outlook. Demand would only grow marginally in response to price increases. Supply would increase due to a steady, but not spectacular, synthetic and frontier development.

[6]The optimistic supply/demand scenario corresponds roughly with high oil prices. Demand will fall due to significant conservation and inter-fuel substitution. Supply would increase sharply due to significant exploitation of oilsands and frontier reserves, as well as the application of expensive enhanced recovery techniques.

[7]By definition, P(FD) + P(SR) + P(SS) = 1.0

[8]The probability estimates assigned to supply and demand cases represent CERI judgement. In future research, these probability estimates could be refined by an analysis of the general perceptions of industry and government.

[9]The National Energy Program projections of demand reductions may be overly optimistic.

[10]J. H. Mohnfeld, "Changing Patterns of Trade," Petroleum Economist, August 1980.

[11]The transportation algorithm utilized was on the I. P. Sharp APL System. The package is designed to run in interactive mode with cost coefficients permanently stored by the system.

[12]See Table D.1 for quality of specific domestic crude types.

Chapter 5

FUTURE RESEARCH

The information presented in previous chapters exemplifies the complex nature of Canadian crude oil supply and demand. Future research by the Institute will delineate the combined effects of changes in these supply and demand patterns. The purpose of this chapter is to outline the general methodology for the next step in our research program, given the overall objectives of the project described in Chapter 1.

5.1 Industry Model

The major tool of analysis will be a computer model of the Canadian refining industry. Given that certain types of crude oil will be refined in certain geographic regions (as outlined in Section 4.2) the model will determine the ability of refiners to adjust refined petroleum product yields to meet market demands. If refiners are unable to adjust product yields to meet all refined petroleum product demands, three options exist. They are:

- Alter refinery feedstock to improve product yield. Crude oil availability will be a limiting factor.
- Increase throughput (if possible) to compensate for yield deficiency. Certain product surpluses will occur.
- Modify physical refinery configuration through addition or expansion of process units. Capital costs are very high.

The model utilized will be a linear programming simulation model of the 38 crude oil refineries operating in Canada. It was developed by the Energy Supplies Allocation Board (ESAB)[1] to allocate crude oil supplies and estimate refinery output in times of oil shortages.

An alternate method of building a regional model of this type is to aggregate the various physical process units of individual refineries within a region. The result is one single hypothetical refinery representing that region's entire refining capability. Based on the physical characteristics of the crude types being run and the flexibility in yields from various process units, the ability of the refinery to meet refined product demands can be evaluated.

This method requires extensive validity checking due to the complex nature of the interface between the various process units and problems inherent in aggregating individual refinery operations. In addition, the designed yield and capacity of refinery units may not accurately reflect the actual operating characteristics of the equipment involved. Therefore, the model may lack a significant degree of accuracy due to its aggregated nature.

The ESAB model operates in a different manner. In accordance with its mandate, ESAB has requested that every refinery in Canada submit data regarding product yields from specific crude types. This yield information shows the actual flexibility the refiner possesses by reporting yields under a max-gasoline operation and max-distillate operation. This eliminates the need for complex simulation of specific refinery process units. These yields describe actual observed refinery performance, therefore the possible discrepancy between hypothetical and actual results is eliminated. In addition, each refinery is evaluated on a stand-alone basis, thus eliminating the inaccuracies related to the use of a single hypothetical regional refinery.

The objective function of the LP formulation is the minimization of refined product surplus or deficiency. Constraints include physical crude oil refining capacity, maximum and minimum refined product production, and non-negativity constraints.

Due to the confidentiality of individual refinery yields, CERI will have access to model results aggregated on a regional basis. These regions are:

- British Columbia
- Prairies
- Ontario
- Quebec
- Atlantic

These regional breakdowns are consistent with data developed in Chapters 2, 3 and 4. The three prairie provinces were aggregated due to the existence of only one major refinery in each of Saskatchewan and Manitoba, and confidentiality requirements are therefore maintained.

The model requires specific refined petroleum product demands for refineries in a given region.[2] The products follow the major Statistics Canada classifications:

- Petrochemical feedstock
- Motor gasoline and aviation gasoline
- Aviation fuel - Kerosene type (Jet A)
- Aviation fuel - Naphtha type (Jet B)
- Stove oil and kerosene
- Diesel
- Light fuel oil
- Heavy fuel oil
- Asphalt
- Lubricating oil and grease

These demand figures must be region specific and will be expressed in thousands of cubic metres per day.

The model has a degree of flexibility regarding the supply of crude oil. Crude oil supply by type may be specified for Canada as a whole, in which case the model will allocate supplies to each region and each refinery based on an optimal utilization of the oil. If the crude oil supplied to each region is specified, the model will optimally allocate crude to each refinery in that region. We intend to take the latter approach.

For Ontario and Quebec, crude supply will be expressed in terms of Interprovincial Pipe Line's sweet or sour mixed blend. Heavy crudes and foreign crude for Quebec and the Atlantic will be specified by type. In western Canada as well, all feedstock availability will be specified by type.

5.2 Impact Analysis

Three major issues will be addressed using the ESAB model. First, what will be the main differences between the representative range of supply/demand scenarios developed in Chapter 4? Second, what would be the impact of certain supply disruptions on the Canadian refining industry? Third, what would be the effect of ESAB allocation of crude oil supplies?

These issues will be dealt with in three phases.

- Representative Scenarios

  This group of model runs will identify the effects of pessimistic, median, and optimistic supply/demand scenarios. They will represent a sensitivity analysis illustrating the expected impacts of varying degrees of dependence on foreign crude and different domestic supply sources.

- Supply Disruption

  Given certain base case conditions, this group of model runs will analyse the impact of crude oil supply disruption from certain sources. Both domestic and foreign crude oil shortages by specific type will be analysed. The sensitivity of refiners to these disruptions will be assessed.

- Government Oil Allocation

  Using supply disruption scenarios as base case conditions, this group of model runs will determine the impact of government allocation of crude oil supplies vis-a-vis the traditional supply patterns before allocation. The net benefits of such an allocation will be analysed. Technically, the model would be allowed to allocate total crude oil supply in what it perceives to be a most optimal manner.

Three major sets of findings will arise from the impact analysis:

- The degree of refinery retrofit or expansion required to meet future refined petroleum product demands will be addressed.
- The economics of such capital expenditures will be evaluated in terms of profitability and risk.
- The impacts of possible supply disruption and subsequent government allocation will be evaluated.

Model runs for this analysis are currently underway. Upon completion of the second research phase, the findings will be presented and discussed as a CERI study.

Footnotes

[1]The Energy Supplies Allocation Board was created by the federal government under the Energy Supplies Emergency Act, 1979. Its sole purpose is to prepare and maintain contingency allocation plans in the case of crude oil or refined petroleum product shortages. The Board has kindly consented to run model simulations on a cost-recovery basis. In part, this co-operation reflects the involvement of Energy, Mines, and Resources Canada as a founding sponsor of the Canadian Energy Research Institute.

[2]Due to interprovincial movement of product, these demand figures are <u>not</u> necessarily demands in that particular region.

APPENDIX A

TABLE A.1a

DOMESTIC CRUDE OIL DENSITY AND SULPHUR

		Density kg/m^3	Sulphur g/kg
B.C.	Blueberry Taylor	820.3	5.0
	Beatton River	820.3	5.0
	B. Lake	848.8	7.0
Alta.	Bow River L & M	855.0	3.0
	Bow River H	901.3	22.3
	BP heavy	922.4	23.1
	Cremona	834.3	2.6
	Federated	821.7	1.7
	Gibson	887.7	15.7
	Gulf Alta	850.4	6.8
	Husky & Manito H	942.7	30.3
	Imp. Ellerslie	843.8	2.0
	Imp. Excelsior	867.6	8.7
	Imp. Leduc	823.6	1.9
	Imp. Redwater	857.0	4.5
	Murphy	849.3	11.9
	Norcen	844.8	1.3
	Peace River	828.0	3.0
	Pembina	835.8	2.1
	Rainbow	829.9	4.2
	Rangeland	846.8	8.0
	Texaco	830.4	1.6
	Trans Prairie: BL	850.4	6.2
	Twining	876.7	12.6
	Valley	825.1	2.5
	Synthetic	855.5	0.5
Sask.	Bow River H	909.4	18.7
	Husky & Manito H	962.6	33.3
	South Sask. H	921.2	29.7
	Westspur H	872.9	22.1
	Westspur Batch Light	867.6	12.0
	SE Sask. light	843.3	12.1
Man.	Trans Prairie	846.3	14.5

SOURCE: Background data from: A. M. H. Gutek, and E. L. Astete, "Canadian Crude Oil: Its Changes and Refining Implications," Journal of Canadian Petroleum Technology, October-December 1979.

TABLE A.1b

FOREIGN CRUDE OIL DENSITY AND SULPHUR

Country	Stream	Density kg/m^3	Sulphur g/kg
Abu Dhabi	Murban	829.9	8.0
	Umm Shaif	839.6	14.0
	Zakum	825.1	10.0
Algeria	Arzew	804.9	1.0
	Condensate	723.8	1.0
	Sahara Bld	806.3	1.0
	Zarzaitine	820.3	0
Angola	Cabinda	865.4	2.0
Dubai	Dubai	835.6	17.0
Egypt	Gulf Suez	860.2	14.0
Equidor	Oriente	876.2	9.0
Gabon	Mandji	876.2	12.0
Iran	Fereidoon	870.6	26.0
	Iran Heavy	870.6	16.0
	Iran Light	855.0	14.0
	Rostam	849.0	16.0
	Sassan	855.0	19.0
	Basrah	849.6	21.0
	Basrah Med.	876.2	26.0
	Kirkuk	849.6	21.0
	Rumaila	849.6	21.0
Kuwait	Kuwait	870.6	25.0
Libya	Brega	825.1	2.0
	Es Sider	839.6	4.0
	Lib-Conden.	785.0	15.0
	Sarir	829.9	1.0
	Zueitina	820.3	2.0
Mexico	Isthmus	855.0	15.0
	Maya	915.9	23.0
Nigeria	Expt. Blend	870.6	2.0
	Light	839.6	1.0
	Medium	898.4	2.0
	Qua Iboe	839.8	1.0
Neutral Zone	Hout	849.6	17.0
	Khafji	887.1	29.0
Oman	Expt. Blend	844.6	7.0
Qatar	Dukan	825.1	12.0
	Marine	844.6	15.0
Saudi Arabia	Arab Heavy	892.7	28.0
	Arab Light	855.0	17.0
	Arab Medium	870.6	24.0
Soviet Union	Romashkinskaya	862.3	16.0
Trinidad	Blend	857.1	2.3
United Kingdom	Flotta	844.6	12.0
	Forties	839.6	3.0
Ural	Ural Light	865.4	14.0
Venezuela	Bach/Ceuta	910.0	18.0
	Bachequero	879.2	23.0
	Boscan	995.0	54.0
	Ceuta	881.6	14.0
	Guanipan	876.2	11.6
	La Rosa	910.0	18.0
	Lagomar	870.6	14.5
	Lagomedio	865.4	13.0
	Lagotreco	870.8	13.0
	Laguna	953.0	28.0
	Leona	910.0	15.0
	Oficina	855.0	7.0
	Pilon	972.5	21.0
	S Rosa C5+	783.9	15.0
	TJ Ind	904.2	18.0
	TJ Light	870.6	13.0
	TJ Medium	898.4	17.0

SOURCE: Petroleum Compensation Board

TABLE A.2

SULPHUR PENALTY SCHEDULE
LIGHT AND MEDIUM CRUDE

Weight Fraction[a] g/kg	Penalty $/m^3
0 - 0.9	0
1.0 - 1.9	.15
2.0 - 2.9	.30
3.0 - 3.9	.45
4.0 - 4.9	.60
5.0 - 5.9	.75
6.0 - 6.9	.90
7.0 - 7.9	1.05
8.0 - 8.9	1.20
9.0 - 9.9	1.35
10.0 - 10.9	1.50
11.0 - 11.9	1.65
12.0 - 12.9	1.80
13.0 - 13.9	1.95
14.0 - 14.9	2.10
15.0 - 15.9	2.25
16.0 - 16.9	2.40
17.0 - 17.9	2.55
18.0 - 18.9	2.70
19.0 - 19.9	2.85
20.0 - 20.9	3.00
21.0 - 21.9	3.15
22.0 - 22.9	3.30
23.0 - 23.9	3.45
24.0 - 24.9	3.60

SOURCE: Alberta Petroleum Marketing Commission

[a]Sulphur weight fraction is not rounded.

TABLE A.3

DENSITY PENALTY SCHEDULE
LIGHT AND MEDIUM CRUDE

kg/m^3 [a]	Penalty $\$/m^3$
- 815	0
816 - 820	.20
821 - 825	.40
826 - 830	.60
831 - 835	.80
836 - 840	1.00
841 - 845	1.20
846 - 850	1.40
851 - 855	1.60
856 - 860	1.80
861 - 865	2.00
866 - 870	2.20
871 - 875	2.40
876 - 880	2.60
881 - 885	2.80
886 - 890	3.00
891 - 895	3.20
896 - 900	3.40
901 - 905	3.60
906 - 910	3.80
911 - 915	4.00
916 - 920	4.20
921 - 925	4.40
926 - 930	4.60
931 - 935	4.80

SOURCE: Alberta Petroleum Marketing Commission

[a]Density is to be rounded to nearest kg/m^3.

TABLE A.4

LOW CASE SUPPLY FORECAST
$10^3 m^3/d$

		1981	1985	1990	1995	2000
B.C.	Blueberry Taylor	1.4	1.2	0.7	0.4	0.3
	Beatton River	1.2	0.7	0.4	0.1	0.1
	B. Lake	2.0	1.5	1.2	1.0	0.7
	Ext. & Discoveries	-	0.9	1.8	0.7	0.7
	Tertiary	-	-	-	0.7	0.7
	Pentanes Plus	0.9	0.9	0.9	1.8	0.9
N.W.T.	Norman Wells	0.4	3.5	3.5	3.1	2.5
Alta.	Bow River L & M	1.0	0.6	0.4	0.2	0.1
	Bow River M	5.8	3.1	1.7	1.0	0.4
	BP heavy	0.7	0.4	0.3	0.2	0.1
	Cremona	2.3	1.0	0.4	0.1	-
	Federated	27.9	21.0	14.6	11.1	8.8
	Gibson	0.8	0.6	0.4	0.4	0.3
	Gulf Alta	12.1	6.0	2.2	1.5	0.8
	Husky & Manito M	3.2	2.3	1.4	0.9	0.6
	Imp. Ellerslie	3.7	3.0	1.2	0.4	0.3
	Imp. Excelsior	0.5	0.3	1.3	0.1	0.1
	Imp. Leduc	1.3	0.6	0.4	0.2	0.1
	Imp. Redwater	6.2	2.4	1.5	1.0	0.9
	Murphy	0.3	0.2	0.1	-	-
	Norcen	0.5	1.0	0.6	0.3	0.2
	Peace River	11.6	8.7	5.3	3.1	1.7
	Pembina	16.5	14.2	9.2	5.9	4.6
	Rainbow	25.8	20.9	9.8	4.6	2.5
	Rangeland	7.0	4.9	2.5	1.7	1.1
	Texaco	23.1	9.8	2.6	0.6	0.1
	Trans Prairie: BL	0.5	0.4	0.3	0.2	0.1
	Twining	0.6	0.4	0.3	0.2	0.1
	Valley	0.4	0.4	0.4	0.3	0.3
	Synthetic	18.0	26.0	72.0	80.0	80.0
	Ext. & Discoveries	1.8	9.0	16.2	17.5	17.5
	Tertiary	-	4.5	15.3	17.5	21.0
	Pentanes Plus	17.1	12.6	9.9	5.4	1.8
Sask.	Bow River M	1.9	1.4	1.0	0.6	0.4
	Husky & Manito M	5.0	4.2	2.1	1.1	0.4
	South Sask. M	5.0	3.6	2.3	1.5	1.1
	Westspur M	4.7	3.5	2.4	1.7	1.3
	Westspur Batch Light	0.4	0.3	0.2	0.1	0.1
	SE Sask. light	5.0	3.3	1.9	1.0	0.6
	Synthetic	-	-	-	-	-
	Ext. & Discoveries	3.6	9.0	9.0	8.0	7.0
	Tertiary	-	-	1.8	3.5	7.0
	Pentanes Plus	-	-	-	-	-
Man.	Trans Prairie	1.3	1.0	0.8	0.5	0.3
Ont.	Light	0.2	0.2	0.2	0.1	0.3
Frontier		-	-	-	-	-
All	Total	221.7	189.6	200.5	180.3	167.9

TABLE A.5

BASE CASE SUPPLY FORECAST
$10^3 m^3/d$

		1981	1985	1990	1995	2000
B.C.	Blueberry Taylor	1.6	1.3	0.8	0.5	0.3
	Beatton River	1.3	0.8	0.4	0.1	0.1
	D. Lake	2.2	1.7	1.3	1.1	1.8
	Ext. & Discoveries	-	1.0	2.0	1.0	1.0
	Tertiary	-	-	-	1.0	1.0
	Pentanes Plus	1.0	1.0	1.0	2.0	1.0
N.W.T.	Norman Wells	0.4	3.9	3.9	3.5	2.8
Alta.	Bow River L & M	1.1	0.7	0.4	0.2	0.1
	Bow River H	6.4	3.5	1.9	1.1	0.4
	BP heavy	0.8	0.5	0.3	0.2	0.1
	Cremona	2.5	1.1	< 0.4	0.1	-
	Federated	31.0	23.3	16.2	12.3	9.8
	Gibson	0.9	0.7	0.5	0.4	0.3
	Gulf Alta	13.4	6.7	2.5	1.5	0.9
	Husky & Manito H	3.5	2.6	1.6	1.0	0.7
	Imp. Ellerslie	4.1	3.3	1.3	0.4	0.3
	Imp. Excelsior	0.6	0.3	1.5	0.1	0.1
	Imp. Leduc	1.4	0.7	0.4	0.2	0.1
	Imp. Redwater	6.9	2.7	1.7	1.1	1.0
	Murphy	0.3	0.2	0.1	-	-
	Norcen	0.6	1.1	0.7	0.3	0.2
	Peace River	12.9	9.7	5.9	3.4	1.9
	Pembina	18.3	15.8	10.2	6.6	5.1
	Rainbow	28.7	23.2	10.9	5.1	2.8
	Rangeland	7.8	5.4	2.8	1.9	1.2
	Texaco	25.7	10.9	2.9	0.7	0.1
	Trans Prairie: BL	0.6	0.4	0.3	0.2	0.1
	Twining	0.7	0.5	0.3	0.2	0.1
	Valley	0.5	0.5	0.4	0.3	0.3
	Synthetic	20.0	29.0	80.0	100.0	120.0
	Ext. & Discoveries	2.0	10.0	18.0	25.0	25.0
	Tertiary	-	5.0	17.0	25.0	30.0
	Pentanes Plus	19.1	14.0	11.0	6.0	2.0
Sask.	Bow River H	2.1	1.6	1.1	0.7	0.5
	Husky & Manito H	5.5	4.7	2.3	1.2	0.5
	South Sask. H	5.5	4.0	2.5	1.7	1.2
	Westspur H	5.2	3.9	2.7	1.9	1.4
	Westspur Batch Light	0.4	0.3	0.2	0.1	0.1
	SE Sask. light	5.5	3.7	2.1	1.1	0.7
	Synthetic	-	-	-	-	-
	Ext. & Discoveries	4.0	10.0	10.0	10.0	10.0
	Tertiary	-	-	2.0	5.0	10.0
	Pentanes Plus	-	-	-	-	-
Man.	Trans Prairie	1.4	1.1	0.9	0.6	0.3
Ont.	Light	0.2	0.2	0.2	0.1	0.1
Frontier		-	-	-	10.0	50.0
All	Total	246.2	211.0	222.6	234.9	285.4

TABLE A.6

HIGH CASE SUPPLY FORECAST
$10^3 m^3/d$

		1981	1985	1990	1995	2000
B.C.	Blueberry Taylor	1.8	1.4	0.9	0.6	0.3
	Beatton River	1.4	0.9	0.4	0.1	0.1
	B. Lake	2.4	1.9	1.4	1.2	0.9
	Ext. & Discoveries	-	1.1	2.2	1.3	1.3
	Tertiary	-	-	-	1.3	1.3
	Pentanes Plus	1.1	1.1	1.1	2.2	1.1
N.W.T.	Norman Wells	0.4	4.3	4.3	3.9	3.1
Alta.	Bow River L & M	1.2	0.8	0.4	0.2	0.1
	Bow River M	7.0	3.9	2.1	1.2	0.4
	BP heavy	0.9	0.6	0.3	0.2	0.1
	Cremona	2.7	1.2	0.4	0.1	-
	Federated	34.1	25.6	17.8	13.5	10.8
	Gibson	1.0	0.8	0.6	0.4	0.3
	Gulf Alta	14.7	7.4	2.8	1.7	1.0
	Husky & Manito M	4.0	2.9	1.6	1.1	0.8
	Imp. Ellerslie	4.5	3.6	1.4	0.4	0.3
	Imp. Excelsior	0.7	0.3	1.7	0.1	0.1
	Imp. Leduc	1.5	0.8	0.4	0.2	0.1
	Imp. Redwater	7.6	3.0	1.9	1.1	1.1
	Murphy	0.3	0.2	0.1	0.1	-
	Norcen	0.7	1.2	0.6	0.3	0.2
	Peace River	14.2	10.7	6.5	3.7	2.1
	Pembina	20.1	17.4	11.2	7.3	5.6
	Rainbow	31.6	25.5	12.0	5.6	3.1
	Rangeland	8.6	5.9	3.1	2.1	1.3
	Texaco	28.3	12.0	3.2	0.8	0.1
	Trans Prairie: BL	0.7	0.4	0.3	0.2	0.1
	Twining	0.8	0.6	0.3	0.2	0.1
	Valley	0.6	0.6	0.4	0.3	0.3
	Synthetic	22.0	31.9	88.0	120.0	160.0
	Ext. & Discoveries	2.2	11.0	19.8	32.5	32.5
	Tertiary	-	5.5	18.7	32.5	39.0
	Pentanes Plus	20.9	15.4	12.1	6.6	2.2
Sask.	Bow River M	2.3	1.8	1.2	0.8	0.6
	Husky & Manito M	6.0	5.2	2.5	1.3	0.6
	South Sask. M	6.0	4.4	2.7	1.9	1.3
	Westspur M	5.7	4.3	3.0	2.1	1.5
	Westspur Batch Light	0.4	0.3	0.2	0.1	0.1
	SE Sask. light	6.0	4.1	2.3	1.2	0.8
	Synthetic	-	-	-	-	-
	Ext. & Discoveries	4.4	11.0	11.0	12.0	13.0
	Tertiary	-	-	2.2	6.5	13.0
	Pentanes Plus	-	-	-	-	-
Man.	Trans Prairie	1.5	1.2	1.0	0.7	0.3
Ont.	Light	0.2	0.2	0.2	0.1	0.3
Frontier		-	-	-	80.0	80.0
All	Total	270.5	232.4	244.7	349.7	381.3

APPENDIX B

APPENDIX B

B.1 Refined Petroleum Product Demand Forecast

Data requirements for future research include a refined petroleum product (RPP) demand forecast by region. The specific products and regions addressed are:

Products	Regions
Petrochemical Feedstock	Atlantic
Motor/Aviation Gasoline	Quebec
Jet A (Kerosene type)	Ontario
Jet B (Naphtha type)	Manitoba
Stove Oil/Kerosene	Saskatchewan
Diesel	Alberta
Light Fuel Oil	British Columbia
Heavy Fuel Oil	Northwest Territories/Yukon
Asphalt	Canada (aggregate)
Lubricating Oil/Grease	
Other	

The three case forecast of total oil demand developed in Section 3.5 has been disaggregated to a product specific basis. For each region, the total oil demand has been divided by 1.05 to determine a total RPP demand that takes into account processing shrinkage. Based on the Shell Canada Limited submission to the National Energy Board, the expected proportional yield of each product was calculated and then applied to the total RPP demand described above. Adjustments were made where necessary to adjust for our perceptions of RPP demand patterns.

The base case for Canada indicates a strong increase in petrochemical, jet fuel, and diesel demand. Motor/aviation gasoline demand will fall steadily to 79 percent of 1981 demand by the year 2000. Light and heavy fuel oil demand will fall fairly rapidly to 63 percent of 1981 demand by the year 2000. Overall, total refined petroleum product demand for Canada is shown to rise only 3 percent over the forecast period.

As noted in Chapter 4, this base case forecast is considered to be somewhat pessimistic. Conservation and substitution could substantially reduce demand estimates for fuel oils and gasoline.

TABLE B.1a

REFINED PETROLEUM PRODUCT DEMAND FORECAST: CANADA
LOW CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	14.1	16.3	15.4	14.6	13.7
Motor/Aviation Gasoline	110.3	97.7	90.0	75.3	68.6
Jet A (Kerosene)	8.5	8.1	10.3	9.7	11.4
Jet B (Naphtha)	5.7	5.4	5.1	7.3	6.9
Stove Oil/Kerosene	5.7	2.7	2.6	2.4	2.3
Diesel	45.3	51.6	61.7	68.0	70.9
Light Fuel Oil	36.8	32.6	28.3	21.9	18.3
Heavy Fuel Oil	42.4	38.0	25.7	24.3	20.6
Asphalt	8.5	8.1	10.3	9.7	9.1
Lubricating Oil/Grease	2.8	2.7	5.1	4.9	4.6
Other	2.8	8.2	2.6	4.8	2.2
Total RPP	282.9	271.4	257.1	242.9	228.6
Total Crude	297.0	285.0	270.0	255.0	240.0

TABLE B.1b

REFINED PETROLEUM PRODUCT DEMAND FORECAST: ATLANTIC
LOW CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0[a]	0[a]	0[a]	0[a]	0[a]
Motor/Aviation Gasoline	9.6	8.5	7.0	6.3	5.9
Jet A (Kerosene)	0.7	1.1	1.0	1.0	1.2
Jet B (Naphtha)	0.4	0.4	0.3	0.3	0.3
Stove Oil/Kerosene	0.7	0.7	0.7	0.6	0.6
Diesel	4.4	4.6	5.0	5.4	5.3
Light Fuel Oil	7.0	6.7	6.0	5.4	4.5
Heavy Fuel Oil	12.9	12.0	12.0	11.3	10.7
Asphalt	0.7	1.1	1.0	0.9	0.9
Lubricating Oil/Grease	0.4	0.4	0.3	0.3	0.3
Other	0[a]	0[a]	0.1	0[a]	0[a]
Total RPP	36.8	35.5	33.4	31.5	29.7
Total Crude	38.6	37.3	35.1	33.1	31.2

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.1c

REFINED PETROLEUM PRODUCT DEMAND FORECAST: QUEBEC
LOW CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	4.6	4.9	5.0	5.0	4.5
Motor/Aviation Gasoline	25.2	22.2	20.7	16.8	14.1
Jet A (Kerosene)	2.3	2.1	2.5	2.8	3.0
Jet B (Naphtha)	0.8	0.7	1.3	1.1	1.0
Stove Oil/Kerosene	1.5	1.4	1.3	0.6	0.5
Diesel	8.4	9.0	11.9	12.9	13.6
Light Fuel Oil	13.8	11.1	9.4	6.7	4.5
Heavy Fuel Oil	15.3	13.9	6.3	5.6	4.5
Asphalt	2.3	2.1	2.5	2.2	2.0
Lubricating Oil/Grease	0.8	0.7	0.6	0.6	0.5
Other	1.4	1.4	1.3	1.6	2.1
Total RPP	76.4	69.5	62.8	55.9	50.3
Total Crude	80.2	73.0	65.9	58.7	52.8

TABLE B.1d

REFINED PETROLEUM PRODUCT DEMAND FORECAST: ONTARIO
LOW CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	10.0	9.4	9.6	8.9	8.2
Motor/Aviation Gasoline	38.3	33.3	30.3	25.9	23.3
Jet A (Kerosene)	2.7	3.4	4.0	3.7	4.1
Jet B (Naphtha)	0.9	0.9	1.6	1.5	1.4
Stove Oil/Kerosene	1.8	0.9	0.8	0.7	0.7
Diesel	10.0	11.1	14.3	15.6	17.2
Light Fuel Oil	12.8	11.1	9.6	8.2	6.2
Heavy Fuel Oil	9.1	9.4	3.2	3.0	2.1
Asphalt	2.7	2.6	2.4	2.2	2.1
Lubricating Oil/Grease	1.8	1.7	1.6	2.2	2.1
Other	1.2	1.7	2.3	2.2	1.2
Total RPP	91.3	85.5	79.7	74.1	68.6
Total Crude	95.9	89.8	83.7	77.8	72.0

TABLE B.1e

REFINED PETROLEUM PRODUCT DEMAND FORECAST: MANITOBA
LOW CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0	0	0	0	0
Motor/Aviation Gasoline	4.7	4.3	3.9	3.4	3.0
Jet A (Kerosene)	0.1	0.1	0.2	0.2	0.1
Jet B (Naphtha)	0.5	0.5	0.6	0.6	0.7
Stove Oil/Kerosene	0.1	0.1	0.1	0[a]	0[a]
Diesel	2.1	2.3	2.5	2.6	2.6
Light Fuel Oil	0.7	0.6	0.5	0.4	0.3
Heavy Fuel Oil	0.4	0.3	0.3	0.3	0.2
Asphalt	0.4	0.3	0.3	0.3	0.3
Lubricating Oil/Grease	0.1	0.1	0.1	0.2	0.1
Other	0[a]	0.1	0[a]	0[a]	0.1
Total RPP	9.1	8.7	8.5	8.0	7.4
Total Crude	9.5	9.1	8.9	8.4	7.8

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.1f

REFINED PETROLEUM PRODUCT DEMAND FORECAST: SASKATCHEWAN
LOW CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0	0	0	0	0
Motor/Aviation Gasoline	5.6	4.9	4.5	4.5	4.1
Jet A (Kerosene)	0[a]	0[a]	0[a]	0[a]	0[a]
Jet B (Naphtha)	0.2	0.2	0.2	0.3	0.3
Stove Oil/Kerosene	0.1	0.1	0.1	0.1	0[a]
Diesel	3.1	3.6	4.1	4.3	4.2
Light Fuel Oil	0.9	0.7	0.6	0.4	0.3
Heavy Fuel Oil	0[a]	0[a]	0[a]	0[a]	0[a]
Asphalt	0.5	0.5	0.5	0.5	0.5
Lubricating Oil/Grease	0.1	0.1	0.1	0.1	0.1
Other	0.3	0.2	0.2	0[a]	0.1
Total RPP	10.8	10.3	10.3	10.2	9.6
Total Crude	11.3	10.8	10.8	10.7	10.1

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.1g

REFINED PETROLEUM PRODUCT DEMAND FORECAST: ALBERTA
LOW CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0	1.9	1.9	1.6	1.6
Motor/Aviation Gasoline	14.0	13.1	11.3	9.6	8.5
Jet A (Kerosene)	1.1	0.9	0.9	1.3	1.3
Jet B (Naphtha)	0.8	0.9	1.3	1.3	1.6
Stove Oil/Kerosene	0[a]	0[a]	0[a]	0[a]	0[a]
Diesel	8.4	10.3	12.6	14.4	15.2
Light Fuel Oil	0.6	0.6	0.3	0.3	0.3
Heavy Fuel Oil	0.3	0.3	0.3	0.3	0[a]
Asphalt	2.0	1.9	1.9	2.2	1.9
Lubricating Oil/Grease	0.3	0.3	0.3	0.3	0.3
Other	0.5	0.9	0.7	0.7	0.9
Total RPP	28.0	31.1	31.5	32.0	31.6
Total Crude	29.4	32.7	33.1	33.6	33.2

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.1h

REFINED PETROLEUM PRODUCT DEMAND FORECAST: BRITISH COLUMBIA
LOW CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0.3	0.3	0[a]	0[a]	0[a]
Motor/Aviation Gasoline	12.0	11.8	10.7	9.9	9.1
Jet A (Kerosene)	0.9	0.9	0.9	0.9	1.2
Jet B (Naphtha)	1.1	1.1	1.2	1.5	1.8
Stove Oil/Kerosene	0.3	0.3	0.3	0.3	0.3
Diesel	7.2	8.1	9.3	10.5	11.4
Light Fuel Oil	2.3	2.0	1.7	1.5	1.2
Heavy Fuel Oil	3.1	3.1	2.9	2.9	2.6
Asphalt	0.9	0.9	0.9	0.9	0.9
Lubricating Oil/Grease	0.3	0.3	0.3	0.3	0.3
Other	0.2	0[a]	0.8	0.4	0.4
Total RPP	28.6	28.8	29.0	29.1	29.2
Total Crude	30.0	30.2	30.4	30.6	30.7

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.1i

REFINED PETROLEUM PRODUCT DEMAND FORECAST: N.W.T. AND YUKON
LOW CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0	0	0	0	0
Motor/Aviation Gasoline	0.4	0.4	0.4	0.3	0.3
Jet A (Kerosene)	0.1	0.1	0.1	0.1	0.1
Jet B (Naphtha)	0.1	0.1	0.1	0.2	0.2
Stove Oil/Kerosene	0.05	0.05	0.1	0.1	0.1
Diesel	0.7	0.7	0.7	0.7	0.8
Light Fuel Oil	0.6	0.6	0.5	0.5	0.5
Heavy Fuel Oil	0.05	0.05	0.1	0.1	0.1
Asphalt	0[a]	0[a]	0[a]	0[a]	0[a]
Lubricating Oil/Grease	0[a]	0[a]	0[a]	0[a]	0[a]
Other	0[a]	0[a]	0[a]	0[a]	0[a]
Total RPP	2.0	2.0	2.0	2.0	2.1
Total Crude	2.1	2.1	2.1	2.1	2.2

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.2a

REFINED PETROLEUM PRODUCT DEMAND FORECAST: CANADA
BASE CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	14.3	17.3	17.4	17.6	17.7
Motor/Aviation Gasoline	111.6	103.7	101.7	90.8	88.6
Jet A (Kerosene)	8.6	8.6	11.6	11.7	14.8
Jet B (Naphtha)	5.7	5.8	5.8	8.8	8.9
Stove Oil/Kerosene	5.7	2.9	2.9	2.9	3.0
Diesel	45.8	54.7	69.7	82.0	91.5
Light Fuel Oil	37.2	34.6	32.0	26.4	23.6
Heavy Fuel Oil	42.9	40.3	29.1	29.3	26.6
Asphalt	8.6	8.6	11.6	11.7	11.8
Lubricating Oil/Grease	2.9	2.9	5.8	5.9	5.9
Other	2.9	8.7	2.9	5.8	2.8
Total RPP	286.2	288.1	290.5	292.9	295.2
Total Crude	300.5	302.5	305.0	307.5	310.0

TABLE B.2b

REFINED PETROLEUM PRODUCT DEMAND FORECAST: ATLANTIC
BASE CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0[a]	0[a]	0[a]	0[a]	0[a]
Motor/Aviation Gasoline	9.7	9.0	7.9	7.6	7.7
Jet A (Kerosene)	0.7	1.1	1.1	1.1	1.5
Jet B (Naphtha)	0.4	0.4	0.4	0.4	0.4
Stove Oil/Kerosene	0.7	0.8	0.8	0.8	0.8
Diesel	4.5	4.9	5.7	6.5	6.9
Light Fuel Oil	7.1	7.2	6.8	6.5	5.8
Heavy Fuel Oil	13.0	12.8	13.6	13.7	13.8
Asphalt	0.7	1.1	1.1	1.1	1.1
Lubricating Oil/Grease	0.4	0.4	0.4	0.4	0.4
Other	0[a]	0[a]	0[a]	0[a]	0[a]
Total RPP	37.2	37.7	37.8	38.1	38.4
Total Crude	39.1	39.6	39.7	40.0	40.3

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.2c

REFINED PETROLEUM PRODUCT DEMAND FORECAST: QUEBEC
BASE CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	4.6	5.2	5.7	6.1	5.9
Motor/Aviation Gasoline	25.5	23.6	23.4	20.2	18.2
Jet A (Kerosene)	2.3	2.2	2.8	3.4	3.9
Jet B (Naphtha)	0.8	0.7	1.4	1.4	1.3
Stove Oil/Kerosene	1.5	1.5	1.4	0.7	0.7
Diesel	8.5	9.6	13.5	15.5	17.6
Light Fuel Oil	13.9	11.8	10.6	8.1	5.9
Heavy Fuel Oil	15.4	14.7	7.1	6.7	5.9
Asphalt	2.3	2.2	2.8	2.7	2.6
Lubricating Oil/Grease	0.8	0.7	0.7	0.7	0.7
Other	1.6	1.5	1.5	1.8	2.3
Total RPP	77.2	73.7	70.9	67.3	65.0
Total Crude	81.1	77.4	74.4	70.7	68.2

TABLE B.2d

REFINED PETROLEUM PRODUCT DEMAND FORECAST: ONTARIO
BASE CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	10.2	10.0	10.8	10.7	10.6
Motor/Aviation Gasoline	38.9	35.4	34.2	31.3	30.1
Jet A (Kerosene)	2.8	3.6	4.5	4.5	5.3
Jet B (Naphtha)	0.9	0.9	1.8	1.8	1.8
Stove Oil/Kerosene	1.9	0.9	0.9	0.9	0.9
Diesel	10.2	11.8	16.2	18.8	22.2
Light Fuel Oil	13.0	11.8	10.8	9.8	8.0
Heavy Fuel Oil	9.3	10.0	3.6	3.6	2.7
Asphalt	2.8	2.7	2.7	2.7	2.7
Lubricating Oil/Grease	1.9	1.8	1.8	2.7	2.7
Other	0.6	1.9	2.7	2.5	1.2
Total RPP	92.5	90.8	90.0	89.3	88.6
Total Crude	97.1	95.3	94.5	93.8	93.0

TABLE B.2e

REFINED PETROLEUM PRODUCT DEMAND FORECAST: MANITOBA
BASE CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0	0	0	0	0
Motor/Aviation Gasoline	4.7	4.5	4.4	4.1	4.0
Jet A (Kerosene)	0.1	0.1	0.2	0.2	0.2
Jet B (Naphtha)	0.5	0.6	0.7	0.8	0.8
Stove Oil/Kerosene	0.1	0.1	0.1	0[a]	0[a]
Diesel	2.1	2.4	2.8	3.0	3.4
Light Fuel Oil	0.7	0.6	0.5	0.5	0.4
Heavy Fuel Oil	0.4	0.4	0.4	0.4	0.3
Asphalt	0.4	0.4	0.4	0.4	0.4
Lubricating Oil/Grease	0.1	0.1	0.1	0.2	0.2
Other	0[a]	0[a]	0[a]	0[a]	0[a]
Total RPP	9.1	9.2	9.6	9.6	9.7
Total Crude	9.6	9.7	10.1	10.1	10.2

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.2f

REFINED PETROLEUM PRODUCT DEMAND FORECAST: SASKATCHEWAN
BASE CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0	0	0	0	0
Motor/Aviation Gasoline	5.7	5.3	5.1	5.4	5.3
Jet A (Kerosene)	0[a]	0[a]	0[a]	0[a]	0[a]
Jet B (Naphtha)	0.2	0.2	0.2	0.4	0.4
Stove Oil/Kerosene	0.1	0.1	0.1	0.1	0[a]
Diesel	3.2	3.9	4.6	5.2	5.5
Light Fuel Oil	0.9	0.8	0.7	0.5	0.4
Heavy Fuel Oil	0[a]	0[a]	0[a]	0[a]	0[a]
Asphalt	0.5	0.6	0.6	0.6	0.6
Lubricating Oil/Grease	0.1	0.1	0.1	0.1	0.1
Other	0.2	0[a]	0.2	0[a]	0.1
Total RPP	10.9	11.0	11.6	12.3	12.4
Total Crude	11.4	11.5	12.2	12.9	13.0

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.2g

REFINED PETROLEUM PRODUCT DEMAND FORECAST: ALBERTA
BASE CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0	2.0	2.2	1.9	2.0
Motor/Aviation Gasoline	14.2	13.9	13.1	11.6	10.8
Jet A (Kerosene)	1.1	1.0	1.1	1.6	1.6
Jet B (Naphtha)	0.9	1.0	1.5	1.6	2.0
Stove Oil/Kerosene	0[a]	0[a]	0[a]	0[a]	0[a]
Diesel	8.5	10.9	14.5	17.4	19.2
Light Fuel Oil	0.6	0.7	0.4	0.4	0.4
Heavy Fuel Oil	0.3	0.3	0.4	0.4	0[a]
Asphalt	2.0	2.0	2.2	2.7	2.4
Lubricating Oil/Grease	0.3	0.3	0.4	0.4	0.4
Other	0.4	1.0	0.5	0.7	1.2
Total RPP	28.3	33.1	36.3	38.7	40.0
Total Crude	29.7	34.8	38.1	40.6	41.9

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.2h

REFINED PETROLEUM PRODUCT DEMAND FORECAST: BRITISH COLUMBIA
BASE CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0.3	0.3	0[a]	0[a]	0[a]
Motor/Aviation Gasoline	12.2	12.6	11.8	11.9	12.0
Jet A (Kerosene)	0.9	0.9	1.0	1.1	1.6
Jet B (Naphtha)	1.2	1.2	1.3	1.8	2.3
Stove Oil/Kerosene	0.3	0.3	0.3	0.4	0.4
Diesel	7.3	8.6	10.2	12.6	15.1
Light Fuel Oil	2.3	2.1	1.9	1.8	1.6
Heavy Fuel Oil	3.2	3.4	3.2	3.5	3.5
Asphalt	0.9	0.9	1.0	1.1	1.2
Lubricating Oil/Grease	0.3	0.3	0.3	0.4	0.4
Other	0.1	0[a]	1.0	0.5	0.6
Total RPP	29.0	30.6	32.0	35.1	38.7
Total Crude	30.4	32.1	33.6	36.9	40.6

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.2i

REFINED PETROLEUM PRODUCT DEMAND FORECAST: N.W.T. AND YUKON
BASE CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0	0	0	0	0
Motor/Aviation Gasoline	0.4	0.4	0.4	0.4	0.4
Jet A (Kerosene)	0.1	0.1	0.1	0.1	0.2
Jet B (Naphtha)	0.1	0.1	0.2	0.2	0.2
Stove Oil/Kerosene	0.05	0.05	0.1	0.1	0.1
Diesel	0.7	0.7	0.8	0.9	1.1
Light Fuel Oil	0.6	0.6	0.6	0.6	0.6
Heavy Fuel Oil	0.05	0.05	0.1	0.1	0.1
Asphalt	0[a]	0[a]	0[a]	0[a]	0[a]
Lubricating Oil/Grease	0[a]	0[a]	0[a]	0[a]	0[a]
Other	0[a]	0[a]	0[a]	0[a]	0[a]
Total RPP	2.0	2.0	2.3	2.4	2.7
Total Crude	2.1	2.1	2.4	2.5	2.8

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.3a

REFINED PETROLEUM PRODUCT DEMAND FORECAST: CANADA
HIGH CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	14.5	18.3	19.4	20.6	21.7
Motor/Aviation Gasoline	112.9	109.7	113.3	106.3	108.6
Jet A (Kerosene)	8.7	9.1	13.0	13.7	18.1
Jet B (Naphtha)	5.8	6.1	6.5	10.3	10.9
Stove Oil/Kerosene	5.8	3.1	3.2	3.4	3.6
Diesel	46.3	57.9	77.7	96.0	112.2
Light Fuel Oil	37.6	36.6	35.6	30.9	29.0
Heavy Fuel Oil	43.4	42.3	32.4	34.3	32.6
Asphalt	8.7	9.1	13.0	13.7	14.5
Lubricating Oil/Grease	2.9	3.1	6.5	6.9	7.2
Other	2.9	9.5	3.2	6.8	3.5
Total RPP	289.5	304.8	323.8	342.9	361.9
Total Crude	304.0	320.0	340.0	360.0	380.0

TABLE B.3b

REFINED PETROLEUM PRODUCT DEMAND FORECAST: ATLANTIC
HIGH CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0[a]	0[a]	0[a]	0[a]	0[a]
Motor/Aviation Gasoline	9.8	9.6	8.8	8.9	9.4
Jet A (Kerosene)	0.7	1.2	1.3	1.3	1.9
Jet B (Naphtha)	0.4	0.4	0.4	0.5	0.5
Stove Oil/Kerosene	0.8	0.8	0.8	0.9	0.9
Diesel	4.5	5.2	6.3	7.6	8.4
Light Fuel Oil	7.1	7.6	7.6	7.6	7.1
Heavy Fuel Oil	13.2	13.5	15.2	16.0	17.0
Asphalt	0.7	1.2	1.3	1.3	1.4
Lubricating Oil/Grease	0.4	0.4	0.4	0.5	0.5
Other	0[a]	0[a]	0[a]	0[a]	0[a]
Total RPP	37.6	39.9	42.1	44.6	47.1
Total Crude	39.5	41.9	44.2	46.8	49.4

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.3c

REFINED PETROLEUM PRODUCT DEMAND FORECAST: QUEBEC
HIGH CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	4.7	5.5	6.3	7.1	7.2
Motor/Aviation Gasoline	25.8	25.0	26.1	23.7	22.3
Jet A (Kerosene)	2.3	2.3	3.2	3.9	4.8
Jet B (Naphtha)	0.8	0.8	1.6	1.6	1.6
Stove Oil/Kerosene	1.6	1.6	1.6	0.8	0.8
Diesel	8.6	10.1	15.0	18.1	21.5
Light Fuel Oil	14.1	12.5	11.9	9.5	7.2
Heavy Fuel Oil	15.6	15.6	7.9	7.9	7.2
Asphalt	2.3	2.3	3.2	3.2	3.2
Lubricating Oil/Grease	0.8	0.8	0.8	0.8	0.8
Other	1.6	1.5	1.5	2.3	3.0
Total RPP	78.2	78.0	79.1	78.9	79.6
Total Crude	82.1	81.9	83.0	82.8	83.6

TABLE B.3d

REFINED PETROLEUM PRODUCT DEMAND FORECAST: ONTARIO
HIGH CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	10.3	10.6	12.1	12.6	13.0
Motor/Aviation Gasoline	39.3	37.4	38.2	36.6	36.9
Jet A (Kerosene)	2.8	3.8	5.0	5.2	6.5
Jet B (Naphtha)	0.9	1.0	2.0	2.1	2.2
Stove Oil/Kerosene	1.9	1.0	1.0	1.1	1.1
Diesel	10.3	12.5	18.1	22.0	27.2
Light Fuel Oil	13.1	12.5	12.1	11.5	9.8
Heavy Fuel Oil	9.4	10.6	4.0	4.2	3.3
Asphalt	2.8	2.9	3.0	3.1	3.3
Lubricating Oil/Grease	1.9	1.9	2.0	3.1	3.3
Other	0.8	1.8	2.9	3.1	2.0
Total RPP	93.5	96.0	100.4	104.6	108.6
Total Crude	98.2	100.8	105.4	109.8	114.0

TABLE B.3e

REFINED PETROLEUM PRODUCT DEMAND FORECAST: MANITOBA
HIGH CASE
($10^3 m^3/d$)

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0	0	0	0	0
Motor/Aviation Gasoline	4.8	4.8	4.9	4.9	4.9
Jet A (Kerosene)	0.1	0.1	0.2	0.2	0.2
Jet B (Naphtha)	0.5	0.6	0.8	0.9	1.1
Stove Oil/Kerosene	0.1	0.1	0.1	0[a]	0[a]
Diesel	2.1	2.5	3.1	3.6	4.2
Light Fuel Oil	0.7	0.7	0.6	0.5	0.5
Heavy Fuel Oil	0.4	0.4	0.4	0.5	0.3
Asphalt	0.4	0.4	0.4	0.5	0.5
Lubricating Oil/Grease	0.1	0.1	0.1	0.2	0.2
Other	0[a]	0.2	0.1	0[a]	0[a]
Total RPP	9.2	9.8	10.7	11.3	11.9
Total Crude	9.7	10.3	11.2	11.9	12.5

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.3f

REFINED PETROLEUM PRODUCT DEMAND FORECAST: SASKATCHEWAN
HIGH CASE
$10^3 m^3/d$

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0	0	0	0	0
Motor/Aviation Gasoline	5.8	5.6	5.7	6.3	6.5
Jet A (Kerosene)	0[a]	0[a]	0[a]	0[a]	0[a]
Jet B (Naphtha)	0.2	0.2	0.3	0.4	0.5
Stove Oil/Kerosene	0.1	0.1	0.1	0.1	0[a]
Diesel	3.2	4.1	5.2	6.1	6.7
Light Fuel Oil	0.9	0.8	0.8	0.6	0.5
Heavy Fuel Oil	0[a]	0[a]	0[a]	0[a]	0[a]
Asphalt	0.6	0.6	0.7	0.7	0.8
Lubricating Oil/Grease	0.1	0.1	0.1	0.1	0.2
Other	0.2	0.1	0.1	0.1	0[a]
Total RPP	11.1	11.6	13.0	14.4	15.2
Total Crude	11.6	12.2	13.6	15.1	16.0

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.3g

REFINED PETROLEUM PRODUCT DEMAND FORECAST: ALBERTA
HIGH CASE
$10^3m^3/d$

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0	2.1	2.4	2.3	2.4
Motor/Aviation Gasoline	14.4	14.7	14.6	13.6	13.2
Jet A (Kerosene)	1.1	1.1	1.2	1.8	2.0
Jet B (Naphtha)	0.9	1.1	1.6	1.8	2.4
Stove Oil/Kerosene	0[a]	0[a]	0[a]	0[a]	0[a]
Diesel	8.6	11.6	16.2	20.3	23.5
Light Fuel Oil	0.6	0.7	0.4	0.5	0.5
Heavy Fuel Oil	0.3	0.4	0.4	0.5	0[a]
Asphalt	2.0	2.1	2.4	3.2	2.9
Lubricating Oil/Grease	0.3	0.4	0.4	0.5	0.5
Other	0.5	0.8	0.9	0.7	1.5
Total RPP	28.7	35.0	40.5	45.2	48.9
Total Crude	30.1	36.8	42.5	47.5	51.3

[a]Less than 0.05 $10^3m^3/d$.

TABLE B.3h

REFINED PETROLEUM PRODUCT DEMAND FORECAST: BRITISH COLUMBIA
HIGH CASE
$10^3 m^3/d$

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0.3	0.3	0[a]	0[a]	0[a]
Motor/Aviation Gasoline	12.3	13.2	13.2	14.0	14.7
Jet A (Kerosene)	0.9	1.0	1.1	1.2	1.9
Jet B (Naphtha)	1.2	1.3	1.4	2.1	2.8
Stove Oil/Kerosene	0.3	0.3	0.4	0.4	0.5
Diesel	7.3	9.0	11.4	14.8	18.5
Light Fuel Oil	2.3	2.3	2.1	2.1	1.9
Heavy Fuel Oil	3.2	3.6	3.6	4.1	4.3
Asphalt	0.9	1.0	1.1	1.2	1.4
Lubricating Oil/Grease	0.3	0.3	0.4	0.4	0.5
Other	0.2	0[a]	0.9	0.8	0.9
Total RPP	29.2	32.3	35.6	41.1	47.4
Total Crude	30.7	33.9	37.4	43.2	49.8

[a]Less than 0.05 $10^3 m^3/d$.

TABLE B.3i

REFINED PETROLEUM PRODUCT DEMAND FORECAST: N.W.T. AND YUKON
HIGH CASE
$10^3 m^3/d$

Product	1981	1985	1990	1995	2000
Petrochemical Feedstock	0	0	0	0	0
Motor/Aviation Gasoline	0.4	0.4	0.4	0.4	0.5
Jet A (Kerosene)	0.1	0.1	0.2	0.2	0.2
Jet B (Naphtha)	0.1	0.1	0.2	0.2	0.2
Stove Oil/Kerosene	0.05	0.1	0.1	0.1	0.1
Diesel	0.7	0.7	0.9	1.0	1.3
Light Fuel Oil	0.6	0.6	0.7	0.7	0.8
Heavy Fuel Oil	0.05	0.1	0.1	0.1	0.1
Asphalt	0[a]	0[a]	0[a]	0[a]	0[a]
Lubricating Oil/Grease	0[a]	0[a]	0[a]	0[a]	0[a]
Other	0[a]	0[a]	0[a]	0.1	0[a]
Total RPP	2.0	2.1	2.6	2.8	3.2
Total Crude	2.1	2.2	2.7	2.9	3.4

[a]Less than 0.05 $10^3 m^3/d$.

APPENDIX C

APPENDIX C

C.1 Model Results for Representative Scenarios

The probability estimates assigned to each supply and demand case were designed to show clear differences between pessimistic, median, and optimistic scenarios. These probability estimates are summarized in Table C.1. For the pessimistic scenario, low case supply and high case demand were assigned high probabilities. For the median scenario, base case supply and base case demand were assigned high probabilities. For the optimistic scenario, high case supply and low case demand were assigned the high probabilities. Tables C.2 through C.6 detail the results of computer model runs using the above probability assignments. Tables C.7 through C.9 summarize these results. Figures C.1 and C.2 depict these summarized results graphically.

The pessimistic scenario shows the expected value of supply deficiency rising quickly to approximately 105 000 m^3/d by 1985, and remaining fairly constant thereafter. The probability of foreign dependence will remain high throughout the forecast period, and self-sufficiency will become only a slight possibility by the year 2000.

The median scenario shows the expected value of net oil deficiency peaking at 91 500 m^3/d in 1985, and then falling steadily to 29 500 m^3/d in 2000. The probability of self-reliance will dominate throughout the forecast period, with the probability self-sufficiency being moderately high by the year 2000.

The optimistic scenario predicts the expected value of net oil deficiency to peak at 75 900 m^3/d in 1995. The situation will be quickly reversed, however, with an expected exportable surplus of 37 200 m^3/d by 2000. The probability of self-reliance will be high in early forecast years, yielding to a high probability of self-sufficiency by the year 2000.

TABLE C.1

SUPPLY AND DEMAND CASE PROBABILITIES

	Pessimistic	Median	Optimistic
Supply			
Low Case	0.6	0.2	0.2
Base Case	0.2	0.6	0.2
High Case	0.2	0.2	0.6
	1.0	1.0	1.0
Demand			
Low Case	0.2	0.2	0.6
Base Case	0.2	0.6	0.2
High Case	0.6	0.2	0.2
	1.0	1.0	1.0

TABLE C.2

CRUDE OIL SUPPLY/DEMAND MATRIX
1981

Pessimistic Scenario

SUPPLY \ DEMAND	low 297.0 p=.2	base 300.5 p=.2	high 304.0 p=.6
low 221.7 p=.6	-75.3 sr	-78.8 sr	-82.3 sr
base 246.1 p=.2	-50.9 sr	-54.4 sr	-57.9 sr
high 270.5 p=.2	-26.5 sr	-30.0 sr	-33.5 sr

ev = -65.6

p(fd) =
p(sr) = 1.00
p(ss) =

Median Scenario

SUPPLY \ DEMAND	low 297.0 p=.2	base 300.5 p=.6	high 304.0 p=.2
low 221.7 p=.2	-75.3 sr	-78.8 sr	-82.3 sr
base 246.1 p=.6	-50.9 sr	-54.4 sr	-57.9 sr
high 270.5 p=.2	-26.5 sr	-30.0 sr	-33.5 sr

ev = -54.4

p(fd) =
p(sr) = 1.00
p(ss) =

Optimistic Scenario

SUPPLY \ DEMAND	low 297.0 p=.6	base 300.5 p=.2	high 304.0 p=.2
low 221.7 p=.2	-75.3 sr	-78.8 sr	-82.3 sr
base 246.1 p=.2	-50.9 sr	-54.4 sr	-57.9 sr
high 270.5 p=.6	-26.5 sr	-30.0 sr	-33.5 sr

ev = -43.2

p(fd) =
p(sr) = 1.00
p(ss) =

TABLE C.3

CRUDE OIL SUPPLY/DEMAND MATRIX
1985

Pessimistic Scenario

SUPPLY	DEMAND: low 285.0 p=.2	base 302.5 p=.2	high 320.0 p=.6
low 189.6 p=.6	-95.4 fd	-112.9 fd	-130.4 fd
base 211.0 p=.2	-74.0 sr	-91.5 sr	-109.0 fd
high 232.4 p=.2	-52.6 sr	-70.1 sr	-87.6 sr

ev = -107.1

p(fd) = .72
p(sr) = .28
p(ss) =

Median Scenario

SUPPLY	DEMAND: low 285.0 p=.2	base 302.5 p=.6	high 320.0 p=.2
low 189.6 p=.2	-95.4 fd	-112.9 fd	-130.4 fd
base 211.0 p=.6	-74.0 sr	-91.5 sr	-109.0 fd
high 232.4 p=.2	-52.6 sr	-70.1 sr	-87.6 sr

ev = -91.5

p(fd) = .32
p(sr) = .68
p(ss) =

Optimistic Scenario

SUPPLY	DEMAND: low 285.0 p=.6	base 302.5 p=.2	high 320.0 p=.2
low 189.6 p=.2	-95.4 fd	-112.9 fd	-130.4 fd
base 211.0 p=.2	-74.0 sr	-91.5 sr	-109.0 fd
high 232.4 p=.6	-52.6 sr	-70.1 sr	-87.6 sr

ev = -75.9

p(fd) = .24
p(sr) = .76
p(ss) =

TABLE C.4

CRUDE OIL SUPPLY/DEMAND MATRIX
1990

Pessimistic Scenario

SUPPLY \ DEMAND	low 270.0 p=.2	base 305.0 p=.2	high 340.0 p=.6
low 200.5 p=.6	-69.5 sr	-104.5 fd	-139.5 fd
base 222.6 p=.2	-47.4 sr	-82.4 sr	-117.4 fd
high 244.7 p=.2	-25.3 sr	-60.3 sr	-95.3 sr

ev = -105.2

p(fd) = .60
p(sr) = .40
p(ss) =

Median Scenario

SUPPLY \ DEMAND	low 270.0 p=.2	base 305.0 p=.6	high 340.0 p=.2
low 200.5 p=.2	-69.5 sr	-104.5 fd	-139.5 fd
base 222.6 p=.6	-47.4 sr	-82.4 sr	-117.4 fd
high 244.7 p=.2	-25.3 sr	-60.3 sr	-95.3 sr

ev = -82.4

p(fd) = .28
p(sr) = .72
p(ss) =

Optimistic Scenario

SUPPLY \ DEMAND	low 270.0 p=.6	base 305.0 p=.2	high 340.0 p=.2
low 200.5 p=.2	-69.5 sr	-104.5 fd	-139.5 fd
base 222.6 p=.2	-47.4 sr	-82.4 sr	-117.4 fd
high 244.7 p=.6	-25.3 sr	-60.3 sr	-95.3 sr

ev = -59.6

p(fd) = .12
p(sr) = .88
p(ss) =

TABLE C.5

CRUDE OIL SUPPLY/DEMAND MATRIX
1995

Pessimistic Scenario

SUPPLY	DEMAND: low 255.0 p=.2	DEMAND: base 307.5 p=.2	DEMAND: high 360.0 p=.6
low 180.3 p=.6	-74.7 sr	-127.2 fd	-179.7 fd
base 234.9 p=.2	-20.1 sr	-72.6 sr	-125.1 fd
high 349.7 p=.2	94.7 ss	42.2 ss	-10.3 sr

ev = -103.4

p(fd) = .60
p(sr) = .32
p(ss) = .08

Median Scenario

SUPPLY	DEMAND: low 255.0 p=.2	DEMAND: base 307.5 p=.6	DEMAND: high 360.0 p=.2
low 180.3 p=.2	-74.7 sr	-127.2 fd	-179.7 fd
base 234.9 p=.6	-20.1 sr	-72.6 sr	-125.1 fd
high 349.7 p=.2	94.7 ss	42.2 ss	-10.3 sr

ev = -60.6

p(fd) = .28
p(sr) = .56
p(ss) = .16

Optimistic Scenario

SUPPLY	DEMAND: low 255.0 p=.6	DEMAND: base 307.5 p=.2	DEMAND: high 360.0 p=.2
low 180.3 p=.2	-74.7 sr	-127.2 fd	-179.7 fd
base 234.9 p=.2	-20.1 sr	-72.6 sr	-125.1 fd
high 349.7 p=.6	94.7 ss	42.2 ss	-10.3 sr

ev = 6.4

p(fd) = .12
p(sr) = .40
p(ss) = .48

TABLE C.6

CRUDE OIL SUPPLY/DEMAND MATRIX
2000

Pessimistic Scenario

SUPPLY	DEMAND low 240.0 p=.2	DEMAND base 310.0 p=.2	DEMAND high 380.0 p=.6
low 167.9 p=.6	-72.1 sr	-142.1 fd	-212.1 fd
base 284.4 p=.2	44.4 ss	-25.6 sr	-95.6 sr
high 381.3 p=.2	141.3 ss	71.3 ss	1.3 ss

ev = -104.1

p(fd) = .48
p(sr) = .28
p(ss) = .24

Median Scenario

SUPPLY	DEMAND low 240.0 p=.2	DEMAND base 310.0 p=.6	DEMAND high 380.0 p=.2
low 167.9 p=.2	-72.1 sr	-142.1 fd	-212.1 fd
base 284.4 p=.6	44.4 ss	-25.6 sr	-95.6 sr
high 381.3 p=.2	141.3 ss	71.3 ss	1.3 ss

ev = -29.5

p(fd) = .16
p(sr) = .52
p(ss) = .32

Optimistic Scenario

SUPPLY	DEMAND low 240.0 p=.6	DEMAND base 310.0 p=.2	DEMAND high 380.0 p=.2
low 167.9 p=.2	-72.1 sr	-142.1 fd	-212.1 fd
base 284.4 p=.2	44.4 ss	-25.6 sr	-95.6 sr
high 381.3 p=.6	141.3 ss	71.3 ss	1.3 ss

ev = 37.2

p(fd) = .08
p(sr) = .20
p(ss) = .72

TABLE C.7

PROBABILITY SUMMARY OF CRUDE OIL SUPPLY/DEMAND SCENARIOS
pessimistic scenario

	1981	1985	1990	1995	2000
Expected Value of Supply Surplus/<deficiency> ($10^3 m^3/d$)	<65.6>	<107.1>	<105.2>	<103.4>	<104.1>
Probability of:					
Foreign Dependence	ø	0.72	0.60	0.60	0.48
Self-Reliance	1.00	0.28	0.40	0.32	0.28
Self-Sufficiency	ø	ø	ø	0.08	0.24
Total Probability	1.00	1.00	1.00	1.00	1.00

TABLE C.8

PROBABILITY SUMMARY OF CRUDE OIL SUPPLY/DEMAND SCENARIOS
median scenario

	1981	1985	1990	1995	2000
Expected Value of Supply Surplus/<deficiency> ($10^3 m^3/d$)	<54.4>	<91.5>	<82.4>	<60.6>	<29.5>
Probability of:					
Foreign Dependence	Ø	0.32	0.28	0.28	0.16
Self-Reliance	1.00	0.68	0.72	0.56	0.52
Self-Sufficiency	Ø	Ø	Ø	0.16	0.32
Total Probability	1.00	1.00	1.00	1.00	1.00

TABLE C.9

PROBABILITY SUMMARY OF CRUDE OIL SUPPLY/DEMAND SCENARIOS
optimistic scenario

	1981	1985	1990	1995	2000
Expected Value of Supply Surplus/<deficiency> ($10^3 m^3/d$)	<43.2>	<75.9>	<59.6>	6.4	37.2
Probability of:					
Foreign Dependence	ø	0.24	0.12	0.12	0.08
Self-Reliance	1.00	0.76	0.88	0.40	0.20
Self-Sufficiency	ø	ø	ø	0.48	0.72
Total Probability	1.00	1.00	1.00	1.00	1.00

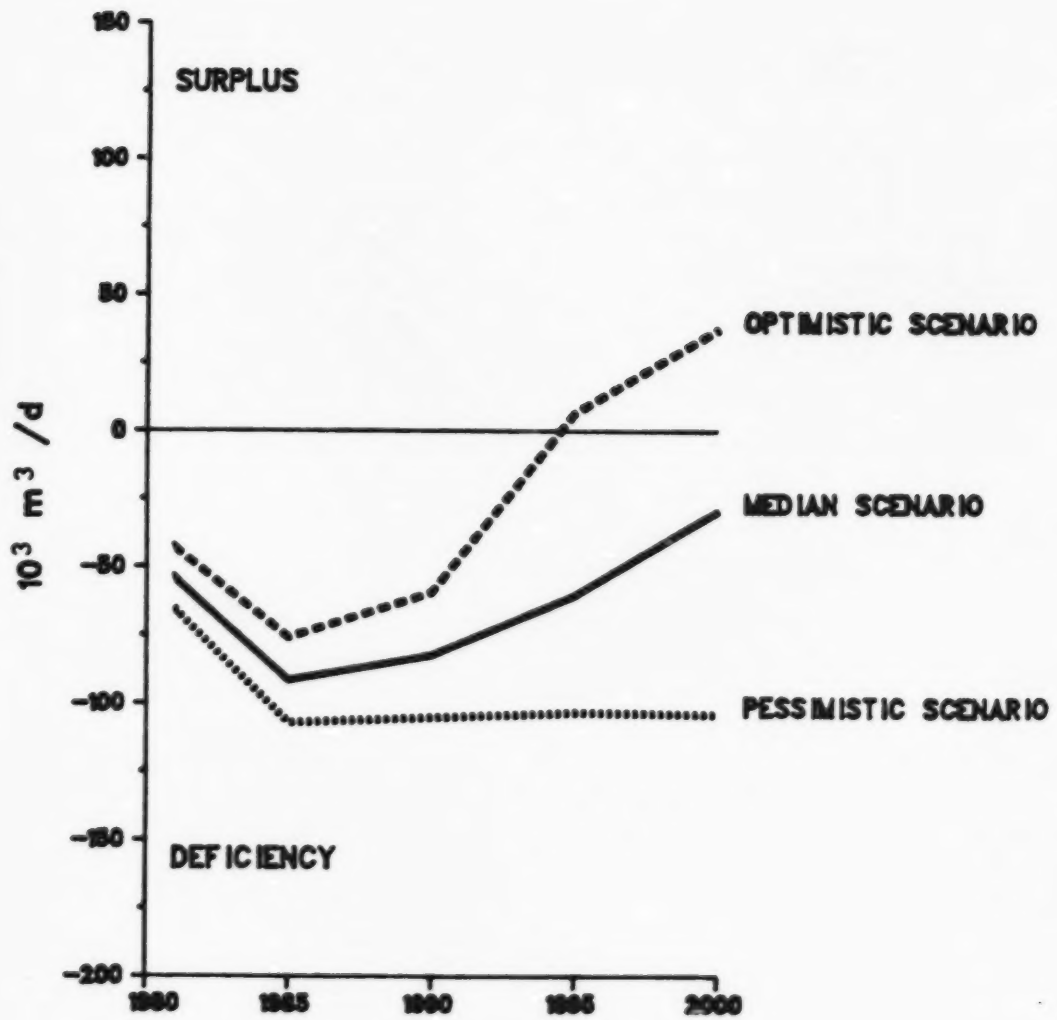


FIGURE C.1: Expected Value of Crude Oil Surplus or Deficiency.
SOURCE: Table C.1 – C.9.

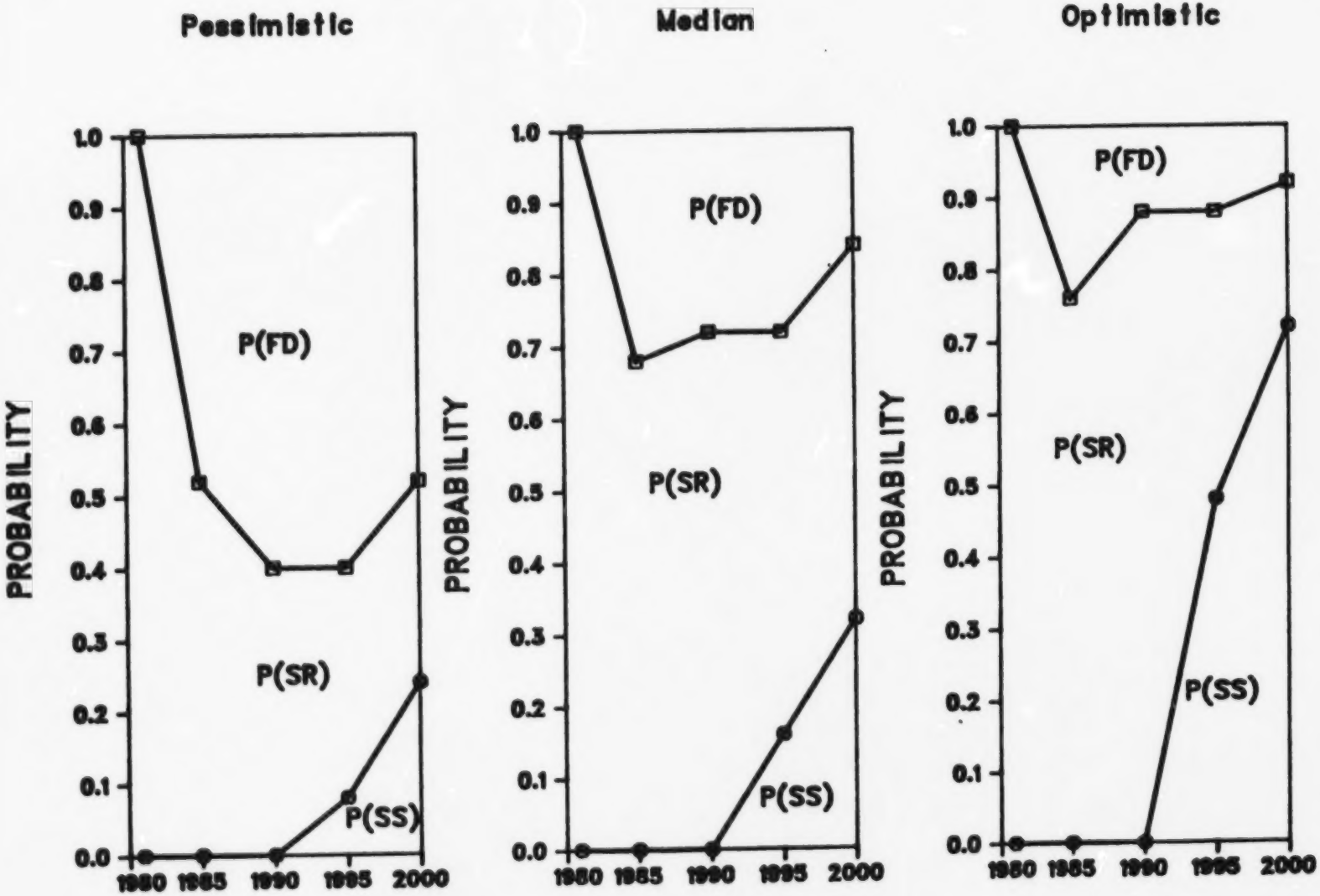


FIGURE C.2: Probabilities of Foreign Oil Dependence.
SOURCE: Table C.1 – C.9.

APPENDIX D

TABLE D.1

QUALITY CLASSIFICATION OF CRUDE STREAMS[a]

Province	Sweet/Light	Sour/Heavy
British Columbia	Blueberry	
	Trans Prairie Beatton	
		Trans Prairie Boundary L.
Alberta	Bow River L & M	
		Bow River Heavy
		BP Exploration
	Cremona	
	Federated	
		Gibson
		Gulf Alberta
		Husky/Manito
	IOL Ellerslie	
		IOL Excelsior
	IOL Leduc	
	IOL Redwater	
		Murphy/Milk River
	Norcen	
	Peace River	
	Pembina	
	Rainbow	
		Rangeland
	Texaco	
		Trans Prairie Boundary L.
		Twining
	Valley	
	Suncor	
	Syncrude	
Saskatchewan		Husky/Manito
		Bow River
		South Sask.
		Westspur SESM
		Westspur Batched Light
		Westspur SESL
Manitoba		Trans Prairie

[a]Based on variation above or below weighted average density and sulphur for 1980. This classification is used in Section 4.2 to allocate specific crude streams to specific refining regions.

TABLE D.2

SOURCE-USE SPECIFIC CRUDE OIL ALLOCATION
BASE CASE SUPPLY/BASE CASE DEMAND
1981
($10^3 m^3/d$)

		B.C.	N.W.T./ Yuk.	Alta.	Sask.	Man.	Ont.	Que.	Atlan.	U.S.	Total
B.C.	Blueberry Taylor	1.6									1.6
	Beatton River	1.3									1.3
	B. Lake	2.2									2.2
	Ext. & Discoveries										0
	Tertiary										0
	Pentanes Plus	1.0									1.0
N.W.T.	Norman Wells		0.4								0.4
Alta.	How River L & M					1.1					1.1
	Bow River H							6.0	0.4		6.4
	BP heavy								0.8		0.8
	Cremona				0.8	0.3	1.4				2.5
	Federated	7.8		15.0	4.2		4.0				31.0
	Gibson							0.9			0.9
	Gulf Alta						4.2	9.2			13.4
	Husky & Manito H			3.6							3.6
	Imp. Ellerslie	4.1						0.6			4.1
	Imp. Excelsior										0.6
	Imp. Leduc	1.4								6.9	1.4
	Imp. Redwater							0.3			6.9
	Murphy					0.6					0.3
	Norcen						8.3				0.6
	Peace River	4.6					18.3				12.9
	Pembina						28.7				18.3
	Rainbow									7.8	28.7
	Rangeland						25.7				7.8
	Texaco										25.7
	Trans Prairie: HL	0.6					0.7				0.6
	Twining										0.7
	Valley			0.5							0.5
	Synthetic	2.2		4.0		1.4	5.6	6.8			20.0
	Ext. & Discoveries							2.0			2.0
	Tertiary										0
	Pentanes Plus			19.1							19.1
Sask.	Bow River H							2.1			2.1
	Husky & Manito H							5.5			5.5
	South Sask. H							5.5			5.5
	Westspur H							5.2			5.2
	Westspur Batch Light							0.4			0.4
	SE Sask. Light							5.5			5.5
	Synthetic										0
	Ext. & Discoveries					4.0					4.0
	Tertiary										0
	Pentanes Plus										0
Man.	Trans Prairie						1.4				1.4
Ont.	Light							0.2			0.2
Frontier											0
Foreign									31.1	39.1	70.2
All	Total	26.8	0.4	42.2	9.0	4.8	97.1	81.1	39.1	15.9	316.4

TABLE D.3

SOURCE-USE SPECIFIC CRUDE OIL ALLOCATION
BASE CASE SUPPLY/BASE CASE DEMAND
1985
($10^3 m^3/d$)

		B.C.	N.W.T. Yuk.	Alta.	Sask.	Man.	Ont.	Que.	Atlan.	U.S.	Total
B.C.	Blueberry Taylor	1.3									1.3
	Beatton River	0.8									0.8
	B. Lake	1.7									1.7
	Ext. & Discoveries	1.0									1.0
	Tertiary										0
	Pentanes Plus	1.0									1.0
N.W.T.	Norman Wells		0.4		3.5						3.9
Alta.	How River L & H				0.7						0.7
	Bow River H							3.5			3.5
	BR heavy							0.5			0.5
	Cremona			1.1							1.1
	Federated			7.3			16.0				23.3
	Gibson							0.7			0.7
	Gulf Alta							6.7			6.7
	Husky & Manito H			2.6							2.6
	Imp. Ellerslie			3.3							3.3
	Imp. Excelsior							0.3			0.3
	Imp. Leduc			0.7							0.7
	Imp. Redwater	2.2		0.5							2.7
	Murphy							0.2			0.2
	Norcen	1.1									1.1
	Peace River	9.7									9.7
	Pembina	10.8				2.8	2.2				15.8
	Rainbow						23.2				23.2
	Rangeland						5.4				5.4
	Texaco						10.9				10.9
	Trans Prairie: H	0.4									0.4
	Twining						0.5				0.5
	Valley			0.5							0.5
	Synthetic			16.0		2.0	6.0	5.0			29.0
	Ext. & Discoveries						10.0				10.0
	Tertiary						5.0				5.0
	Pentanes Plus			14.0							14.0
Sask.	Bow River H							1.6			1.6
	Husky & Manito H						1.7	3.0			4.7
	South Sask. H						4.0				4.0
	Westspur H						3.9				3.9
	Westspur Batch Light							0.3			0.3
	SE Sask. Light							3.7			3.7
	Synthetic										0
	Ext. & Discoveries				4.8		5.2				10.0
	Tertiary										0
	Pentanes Plus										0
Man.	Trans Prairie						1.1				1.1
Ont.	Light						0.2				0.2
Frontier											0
Foreign								51.9	39.6		91.5
All	Total	30.0	0.4	46.0	9.0	4.8	95.3	77.4	39.6	0	302.5

TABLE D.4

SOURCE-USE SPECIFIC CRUDE OIL ALLOCATION
BASE CASE SUPPLY/BASE CASE DEMAND
1990
($10^3 m^3/d$)

		B.C.	N.W.T. Yuk.	Alta.	Sask.	Man.	Ont.	Que.	Atlan.	U.S.	Total
B.C.	Blueberry Taylor	0.8									0.8
	Beatton River	0.4									0.4
	B. Lake	1.3									1.3
	Ext. & Discoveries	2.0									2.0
	Tertiary										0
	Pentanes Plus	1.0									1.0
N.W.T.	Norman Wells		0.4		3.5						3.9
Alta.	Bow River L & M				0.4						0.4
	Bow River H							1.9			1.9
	BP heavy							0.3			0.3
	Cremona			0.4							0.4
	Federated			6.4			9.8				16.2
	Gibson							0.5			0.5
	Gulf Alta							2.5			2.5
	Husky & Manito M			1.6							1.6
	Imp. Ellerslie			1.3							1.3
	Imp. Excelsior							1.5			1.5
	Imp. Leduc			0.4							0.4
	Imp. Redwater			1.7							1.7
	Murphy							0.1			0.1
	Norcen			0.7							0.7
	Peace River			5.9							5.9
	Pembina						10.2				10.2
	Rainbow	8.5		2.4							10.9
	Rangeland					2.8					2.8
	Texaco	2.9									2.9
	Trans Prairie: BL	0.3									0.3
	Twining	0.3									0.3
	Valley			0.4							0.4
	Synthetic	12.5		20.0		2.0	25.5	20.0			80.0
	Ext. & Discoveries						18.0				18.0
	Tertiary						17.0				17.0
	Pentanes Plus			11.0							11.0
Sask.	Bow River H							1.1			1.1
	Husky & Manito H							2.3			2.3
	South Sask. H						2.3	0.2			2.5
	Westspur H						2.7				2.7
	Westspur Batch Light							0.2			0.2
	SE Sask. light						1.0	1.1			2.1
	Synthetic										0
	Ext. & Discoveries				5.1		4.9				10.0
	Tertiary						2.0				2.0
	Pentanes Plus										0
Man.	Trans Prairie						0.9				0.9
Ont.	Light						0.2				0.2
Frontier											0
Foreign								42.7	39.7		82.4
All	Total	30.0	0.4	52.2	9.0	4.8	94.5	74.4	39.7	0	305.0

TABLE D.5

SOURCE-USE SPECIFIC CRUDE OIL ALLOCATION
BASE CASE SUPPLY/BASE CASE DEMAND
1995
($10^3 m^3/d$)

		B.C.	N.W.T. Yuk.	Alta.	Sask.	Man.	Ont.	Que.	Atlan.	U.S.	Total
B.C.	Blueberry Taylor	0.5									0.5
	Beatton River	0.1									0.1
	B. Lake	1.1									1.1
	Ext. & Discoveries	1.0									1.0
	Tertiary	1.0									1.0
	Pentanes Plus	2.0									2.0
N.W.T.	Norman Wells		0.4		3.1						3.5
Alta.	Bow River L & M				0.2						0.2
	Bow River H							1.1			1.1
	BP heavy							0.2			0.2
	Cremona			0.1							0.1
	Federated			12.3							12.3
	Gibson							0.4			0.4
	Gulf Alta						1.4	0.1			1.5
	Husky & Manito H			1.0							1.0
	Imp. Ellerslie			0.4							0.4
	Imp. Excelsior							0.1			0.1
	Imp. Leduc			0.2							0.2
	Imp. Redwater			1.1							1.1
	Murphy										0
	Norcen			0.3							0.3
	Peace River			3.4							3.4
	Pembina			6.6							6.6
	Rainbow			5.1							5.1
	Rangeland					1.9					1.9
	Texaco			0.7							0.7
	Trans Prairie: HI	0.2									0.2
	Twining			0.2							0.2
	Valley			0.3							0.3
	Synthetic	20.0		21.1		2.9	36.0	20.0			100.0
	Ext. & Discoveries						25.0				25.0
	Tertiary	4.1					20.9				25.0
	Pentanes Plus			6.0							6.0
Sask.	Bow River H						0.7				0.7
	Husky & Manito H						1.2				1.2
	South Sask. H						1.7				1.7
	Westspur H						1.9				1.9
	Westspur Batch Light							0.1			0.1
	SE Sask. Light							1.1			1.1
	Synthetic				5.7		4.3				10.0
	Ext. & Discoveries							5.0			5.0
	Tertiary										0
	Pentanes Plus						0.6				0.6
Man.	Trans Prairie						0.1				0.1
Ont.	Light								10.0		10.0
Frontier								42.6	30.0		72.6
Foreign											307.5
All	Total	30.0	0.4	58.8	9.0	4.8	93.8	70.7	40.0	0	

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